

PRELIMINARY ENDANGERMENT ASSESSMENT GUIDANCE MANUAL

(A guidance manual for evaluating hazardous substance release sites.)



State of California
Environmental Protection Agency

Department of Toxic Substances Control
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TABLE OF CONTENTS

List of Figures and Tables	vi
List of Acronyms	vii
Preface	viii
Acknowledgements	ix

CHAPTER 1 INTRODUCTION

1.1 Organization of this Manual	1-1
1.2 Definition/Objectives of the PEA	1-1
1.3 The PEA within the Site Mitigation Process	1-2
1.4 Cost Recovery	1-6

CHAPTER 2 THE PEA INVESTIGATION

2.1 Scoping Recovery	1-2-1
2.1.1 Scoping Meeting	2-1
2.1.2 Conceptual Site Model	2-1
2.2 Public Participation	2-3
2.2.1 Community Assessment	2-3
2.2.2 Community Profile	2-4
2.3 Background Research	2-4
2.3.1 Records Review	2-5
2.3.2 Site Inspection	2-6
2.3.3 Interviews	2-6
2.4 Data Collection and Evaluation	2-7
2.4.1 Workplan Preparation	2-7
2.4.2 Sampling Strategy	2-8
2.4.2.1 Soil Sampling (Vadose Zone)	2-9
2.4.2.2 Ground Water Sampling	2-10
2.4.2.3 Surface Water Sampling	2-11

2.4.2.4	Air Sampling	2-11
2.4.2.5	Background Sampling	2-11
2.4.3	Quality Assurance/Quality Control Measures	2-12
2.4.4	Health and Safety Requirements	2-13
2.4.5	Additional Regulatory Requirements	2-13
2.4.6	Data Evaluation	2-14
2.4.6.1	Evaluation of Analytical Methods	2-14
2.4.6.2	Evaluation of Detection Limits	2-15
2.4.6.3	Evaluation of Qualified Data	2-15
2.4.6.4	Evaluation of Blanks	2-15
2.4.6.5	Evaluation of Tentatively Identified Compounds	2-16
2.4.6.6	Comparison of Site Data with Background	2-16
2.4.6.7	Identification of Chemicals of Potential Concern	2-16
2.5	Human Health Screening Evaluation	2-16
2.5.1	Screening Evaluation Assumptions and Exposure Factors	2-17
2.5.1.1	Land Use	2-17
2.5.1.2	Exposure Pathways and Media of Exposure	2-17
2.5.1.3	Chemical Groups	2-18
2.5.1.4	Exposure Point Concentrations	2-19
2.5.1.5	Toxicity Values	2-20
2.5.2	Risk/Hazard Characterization	2-21
2.5.2.1	Selection of Pathways	2-21
2.5.2.2	Water Pathway	2-24
2.5.2.3	Soil Pathway	2-25
2.5.2.4	Air Pathway	2-25
2.5.2.5	Estimation of Air Concentration	2-25
2.5.2.6	Summation of Risk/Hazard for all Media	2-26
2.5.2.7	Uncertainty Analysis	2-26
2.6	Ecological Screening Evaluation	2-31
2.6.1	Site Characterization	2-31
2.6.2	Biological Characterization	2-32
2.6.3	Pathway Assessment	2-32
2.6.4	Qualitative Summary	2-33

CHAPTER 3 PREPARATION OF THE PEA REPORT

3.1	Documentation Guidelines	3-1
3.2	Suggested Report Format	3-1

3.3 Required Report Contents	3-1
3.3.1 Executive Summary	3-1
3.3.2 Introduction	3-1
3.3.3 Site Description	3-3
3.3.3.1 Site Identification	3-3
3.3.3.2 Site Maps	3-3
3.3.4 Background	3-3
3.3.4.1 Site Status and History	3-3
3.3.4.2 Hazardous Substance/Waste Management Information	3-4
3.3.5 Apparent Problem	3-5
3.3.6 Environmental Setting	3-5
3.3.6.1 Factors Related to Soil Pathways	3-5
3.3.6.2 Factors Related to Water Pathways	3-6
3.3.6.3 Factors Related to Air Pathways	3-7
3.3.7 Sampling Activities and Results	3-8
3.3.7.1 Summary of Activities	3-8
3.3.7.2 Presentation of Data	3-8
3.3.7.3 Discussion of Results	3-9
3.3.8 Human Health Screening Evaluation	3-9
3.3.8.1 Exposure Pathways and Media of Concern	3-9
3.3.8.2 Exposure Concentration and Chemicals	3-9
3.3.8.3 Toxicity Values	3-9
3.3.8.4 Risk Characterization Summary	3-9
3.3.9 Ecological Screening Evaluation	3-10
3.3.9.1 Site Characterization	3-10
3.3.9.2 Biological Characterization	3-10
3.3.9.3 Pathway Assessment	3-10
3.3.9.4 Qualitative Summary	3-10
3.3.10 Community Profile	3-11
3.3.11 Conclusions and Recommendations	3-11
3.3.11.1 Summary and Conclusions	3-11
3.3.11.2 Recommendations	3-11
3.3.11.3 Preliminary Scoping Recommendations	3-12

GLOSSARY

REFERENCES

APPENDICES

A - Tables for Use with Screening Evaluations

B - Derivations for Equations and Complete Equation for VOC Emission Model

LIST OF FIGURES AND TABLES

FIGURES

PAGE

Chapter 1

1.1	Department of Toxic Substances Control, Site Mitigation Process	1-3
1.2	Preliminary Endangerment Assessment Process	1-5

Chapter 2

2.1	Conceptual Site Model	2-2
2.2	Calculation of Risk/Hazard for Water	2-22
2.3	Calculation of Risk/Hazard for Soil	2-23
2.4	Calculation of Risk/Hazard for Air	2-24
2.5	Calculation of Saturation Concentration for VOCs	2-27
2.6	Calculation of Emission Rate for VOCs	2-28
2.7	Estimation of Air Concentration for VOCs	2-29
2.8	Estimation of Air Concentration for non-VOCs	2-30

Chapter 3

3.1	Suggested Report Format	3-2
-----	-------------------------------	-----

Appendix B

1	Derivation of Risk Equation for non-VOCs in Water	B-7
2	Derivation of Risk Equation for VOCs in Water	B-8
3	Derivation of Hazard Equation for non-VOCs in Water	B-9
4	Derivation of Hazard Equation for VOCs in Water	B-10
5	Derivation of Hazard Equation for Soil	B-11
6	Derivation of Hazard Equation for Soil	B-12
7	Derivation of Risk Equation for Air	B-13
8	Derivation of Hazard Equation Air	B-14

TABLES

PAGE

Chapter 2

2-1	Quality Assurance/Quality Control Samples	2-12
2-2	Examples of Potentially Unsuitable Data Types	2-14

Appendix A

1	Predicted Kp Estimates for Common Pollutants	A-1
2	Screening Level Dermal Absorption Fractions (ABS) from Soil	A-6
3	Physical and Chemical Properties for Volatile Compounds	A-7
4	Sample Exposure Pathway Analysis for Ecological Screening Evaluation	A-8

LIST OF ACRONYMS

Cal/EPA	- California Environmental Protection Agency
DFG	- California Department of Fish and Game
DOT	- Department of Transportation
DWR	- California Department of Water Resources
OSA	- Office of Scientific Affairs, California Department of Toxic Substances Control
OSHA	- Occupational Safety and Health Administration
RWQCB	- Regional Water Quality Control Board
SWRCB	- State Water Resources Control Board
USEPA	- United States Environmental Protection Agency
USGS	- United States Geological Service
CERCLIS	- Comprehensive Environmental Response, Compensation and Liability Information System
CEQA	- California Environmental Quality Act
HEAST	- Health Effects Assessment Summary Tables
HWIS	- Hazardous Waste Information System
IRIS	- Integrated Risk Information System
NDDB	- Natural Diversity Database
ARAR	- Applicable or Relevant and Appropriate Requirement
CCR	- California Code of Regulations
CERCLA	- Comprehensive Environmental Response, Compensation and Liability Act
CFR	- Code of Federal Regulations
HSC	- Health and Safety Code
RCRA	- Resource Conservation and Recovery Act
MCL	- Maximum Contaminant Level
NCP	- National Contingency Plan
NPL	- National Priorities List
PA/SI	- Preliminary Assessment/Site Investigation
PEA	- Preliminary Endangerment Assessment
PRG	- Preliminary Remediation Goal
PRP	- Potential Responsible Parties
QA/QC	- Quality Assurance/Quality Control
RfC	- Reference Concentration
RfD	- Reference Dose
RI/FS	- Remedial Investigation/Feasibility Study
SF	- Slope Factor (also Cancer Potency Factor)
SSP	- Site Safety Plan
TSD	- Treatment, Storage, and Disposal
VOC	- Volatile Organic Chemical

PREFACE

This document replaces the Interim Guidance for Preparation of a Preliminary Endangerment Assessment Report (DHS 1990). The previous guidance should no longer be used; however, issuance of this new manual does not invalidate Preliminary Endangerment Assessments completed before (or in progress prior to) its release. This revised guidance manual addresses a number of issues raised since application of the previous manual and differs from previous guidance most significantly in the methodology for conducting the human health and ecological screening evaluations.

The primary intended users of the manual are environmental consultants conducting PEAs for private parties with Department of Toxic Substances Control (Department) oversight. Because experience and professional judgement are vital for drawing the conclusions and presenting the recommendations requisite in the PEA, private parties are responsible for procuring the services of an environmental professional when preparing a PEA report. The manual will also be used by State Contractors and Department staff conducting PEAs with State funds. Other agencies or private entities requiring the use of the manual will be responsible for acting as lead agency and providing oversight for the project.

The PEA incorporates much of the information required for completion of the preliminary assessment and site

inspection (PA/SI) investigations formerly conducted as part of the Department's site mitigation process and currently used by the USEPA. The PEA also has background information requirements similar to a Phase I Environmental Site Assessment required by most lending institutions prior to commercial real estate transactions. Although overall PEA requirements are more comprehensive than requirements for the PA/SI and Phase I Assessments, it is anticipated that information gathered for the PEA may also be useful for those purposes. Specific requirements of the PEA that are not typically required for these other types of investigations include the site specific human health and ecological screening evaluations, public participation requirements, and scoping activities.

As written, the manual attempts to provide useful guidance for all possible site sizes and scenarios. A critical goal of scoping the PEA is to agree upon the focus of the PEA investigation and the degree to which each requirement in the manual applies to the subject site. Although each element of the PEA report must be addressed, the scope of the investigation and level of detail required for each section is discussed with the Department's project manager overseeing the PEA activities. This manual is not intended to be a "cook book" of mandatory ingredients required to produce a PEA report. Each section should be reviewed to determine the appropriate level of action for a given site.

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CHAPTER ONE

INTRODUCTION

The Preliminary Endangerment Assessment (PEA) provides basic information for determining if there has been a release of a hazardous substance that presents a risk to human health or the environment. With the passage of Senate Bill 475 in July 1989, the PEA became a formal step in the site mitigation process of the Department of Toxic Substances Control (Department). The PEA was incorporated into the site mitigation process to establish a mechanism for determining if known or potential hazardous substance sites require immediate or long-term remedial actions by the Department or with Department oversight.

1.3 ORGANIZATION OF THIS MANUAL

This guidance manual is organized into three chapters. Chapter 1 provides background information defining the PEA, explains how the PEA ties into the site mitigation process and discusses the Department's responsibility to recover costs associated with oversight of the PEA. Chapter 2 provides technical guidance for conducting the PEA investigation, which includes scoping the project, acquiring background information, procedures for gathering reliable chemical and physical data, and methodologies for conducting the human health and ecological screening evaluations. Chapter 3 provides the suggested outline for presentation of the PEA investigation results in a PEA report. Chapter 3 also provides general guidance on how to organize the PEA report and a detailed description of

information that should be included in the report.

This manual also includes two appendices: Appendix A provides tables for use with the Screening Evaluation, and Appendix B provides derivations for the equations used in the Screening Evaluation.

1.2 DEFINITION/OBJECTIVES OF THE PEA

The PEA is defined in California Health and Safety Code, Division 20, Chapter 6.8, Section 25319.5 as follows:

"Preliminary Endangerment Assessment means an activity which is performed to determine whether current or past waste management practices have resulted in the release or threatened release of hazardous substances which pose a threat to public health or the environment."

Specific objectives of the PEA include:

- Determining if a release of hazardous wastes/substances exists at the site and delineating the general extent of the contamination.
- Estimating the potential threat to public health and/or the environment posed by the site and providing an indicator of relative risk among sites.
- Determining if an expedited response

action is required to reduce an existing or potential threat to public health or the environment.

- Completing preliminary project scoping activities to determine data gaps and identify possible remedial action strategies to form the basis for development of a site strategy.
- Providing the data and information necessary to list the site, if necessary, for inclusion in the Department's Annual Workplan.
- Assessing and providing for the informational needs of the community.

1.3 THE PEA WITHIN THE SITE MITIGATION PROCESS

The Department's site mitigation process can be divided into several general phases: site evaluation, expedited response, site characterization, remedial action, certification and operation and maintenance. The PEA is intended to be an initial investigation of contamination and is completed during the site evaluation phase. Elements of the site evaluation phase are discussed in the following section. Figure 1.1 presents a flow chart of the site mitigation process and elements of the site evaluation phase. Detailed information regarding the entire site mitigation process can be obtained by contacting one of the Department's Regional offices or Headquarters office.

The site evaluation phase of the site mitigation process includes activities such as site discovery; site screenings; the PEA; potentially responsible party searches; and site listing activities. Throughout the site evaluation phase, human and ecological risk-based assessments are conducted. The

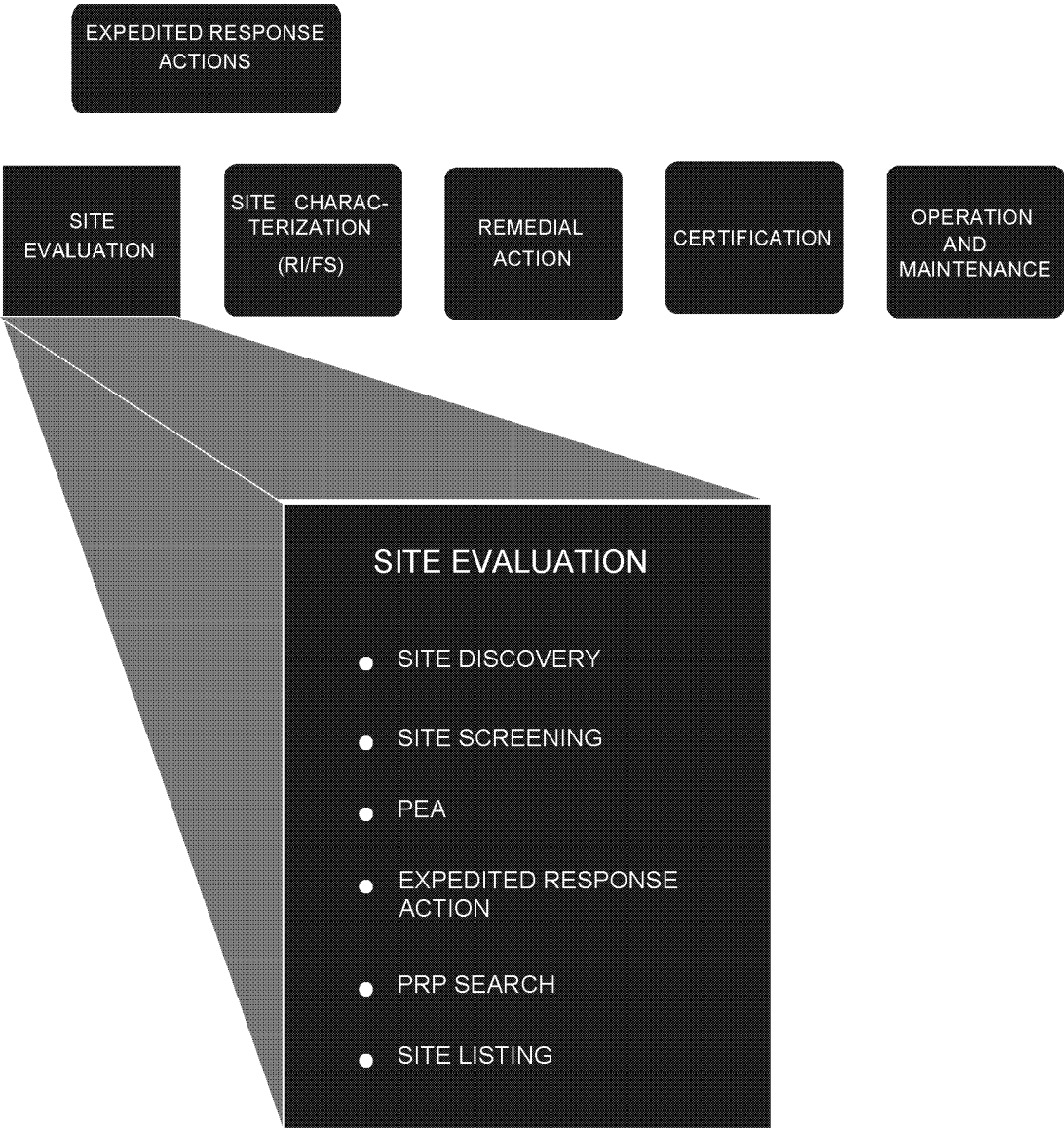
risk-based assessments begin as qualitative judgements which become progressively more quantitative as additional site specific information is collected and factors potentially impacting human health or the environment are evaluated.

At any time during or following the site evaluation phase, an expedited response action may be necessary. Expedited response actions are those actions taken to eliminate any immediate threats to public health or the environment resulting from conditions at the site. These actions generally include but are not limited to fencing the site, capping or coating contaminated areas, removing containers of hazardous substances/wastes, and/or providing alternative water supplies. Expedited response actions should be identified and implemented as early as possible during the site evaluation process.

Site discovery, the first step of site evaluation, involves the identification of known or potentially contaminated sites that were previously unknown to the Department. Following discovery, a site screening is conducted by Regional Department staff to determine whether a site should be evaluated further and whether the site falls within the jurisdiction of Department site mitigation authority. Based on the screening, one or more of the following recommendations will generally be made:

- No further action required;
- Site referred to another agency;
- Site referred to another Departmental program;
- PEA required; and/or
- Expedited response action required.

FIGURE 1.1: DEPARTMENT OF TOXIC SUBSTANCES CONTROL
SITE EVALUATION WITHIN THE SITE MITIGATION PROCESS



Once a site has been screened and the determination made that a PEA is necessary, the responsible person(s) will be notified and requested to contact the Department to initiate the PEA. Typical scenarios for conducting the PEA include:

- The Department identifies a site with a known or suspected release of hazardous substances/wastes and contacts the responsible person(s) to initiate the investigation. The responsible person(s) either agrees to assess the site or the Department issues an administrative order requiring the completion of the PEA with penalties for non-compliance.
- Responsible person(s) contact the Department to obtain oversight for a site assessment prior to a property transfer, development of the property, change in land use, etc.
- A site with a known or suspected release of hazardous substances/wastes is identified, but the responsible person(s) have not been identified and potential or significant public health or environmental threats warrant use of the Department's resources to assess the site.

Figure 1.2 presents a diagram of the PEA process from the point of initiation with the Department to preparation of the final report. As seen in the diagram, Initiate PEA, Background Research, Data Evaluation, and Report Preparation are steps required for all PEA investigations. The majority of the investigation's flexibility lies within Public Participation, Sampling, and Human Health and Environmental Screening Evaluations. These sections are dependent upon site specific circumstances and need not be completed at all sites. However, be advised that exclusion of one or more of these

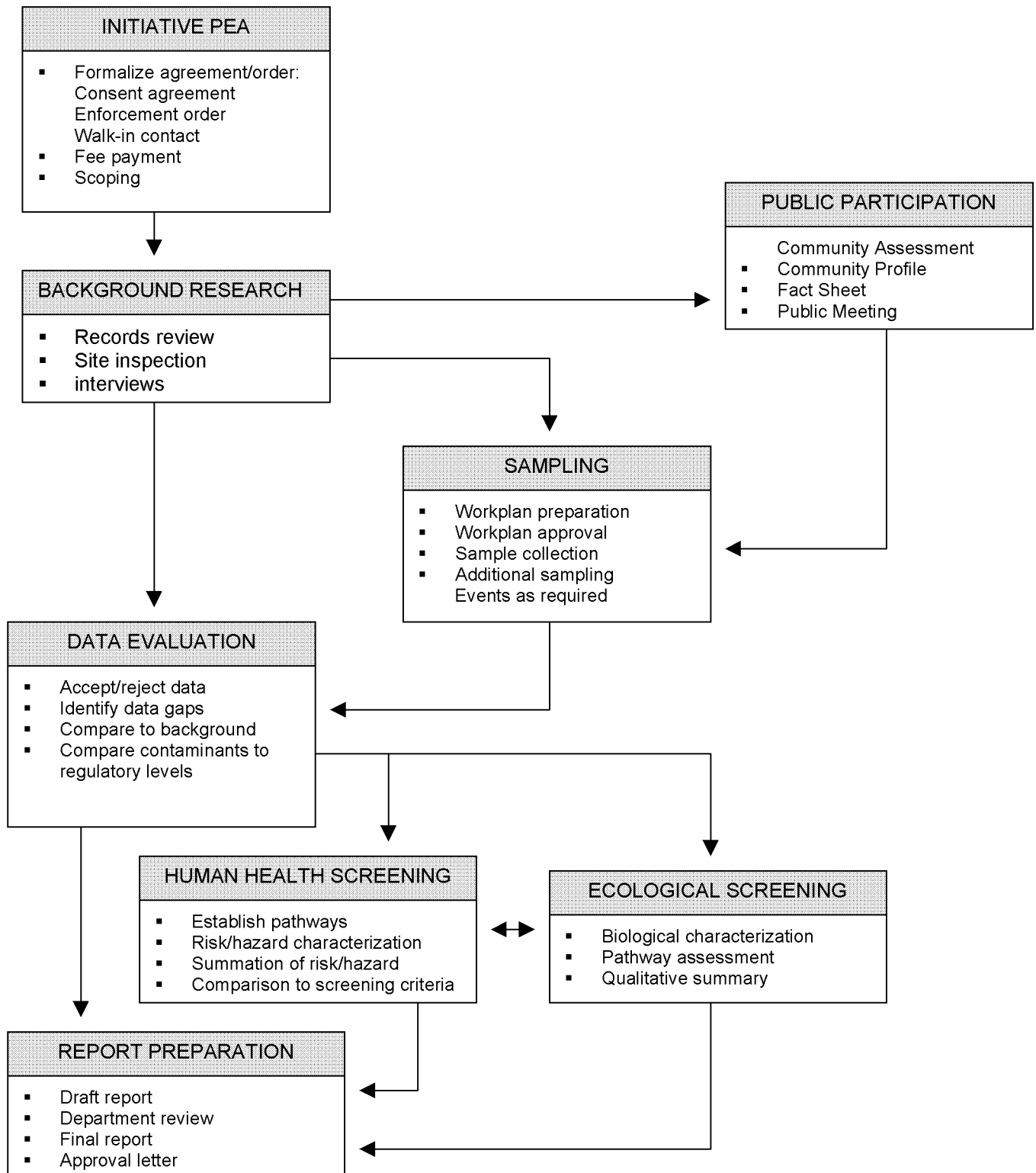
sections will be the exception to the norm and must be approved in advance by Department staff. All of the sections in the diagram are flexible with regard to the level of effort required for each site.

The completed PEA report provides the information necessary to determine the need for further action at the site. Department staff will review the data provided in the PEA report to determine if the recommendations in the report are justified. Sites requiring no further action will be released from Department oversight requirements. However, if at a later date information becomes available which indicates other potential problems exist, the Department may initiate additional investigations at the site. Sites with significant contamination requiring further action will move along in the site mitigation process for removal and/or remedial actions. In either case the Department will issue a letter formalizing completion of the PEA, approving or disputing the recommendations, and detailing any recommendations or requirements not presented in the PEA report that the Department feels are necessary to address onsite contamination.

Department approval of a "no further action" recommendation signifies that the Department's concerns at the site have been addressed; however, other agencies may require further action based on concerns not addressed during the PEA. For example, the Regional Water Quality Control Board (RWQCB) may require actions to protect and restore water quality. Whenever possible, the preparer and Department staff should coordinate with other agencies to address their concerns during the PEA.

Following completion of the PEA, a base-line potentially responsible party (PRP) search (USEPA, 1987b) may be necessary to

**FIGURE 1.2: PRELIMINARY ENDANGERMENT ASSESSMENT
PROCESS DIAGRAM**



identify the principal parties potentially liable for mitigating contamination at the site. Much of the information required to complete the baseline PRP search should be contained in the PEA report. PRPs identified by the search will be required to contribute to the work to be conducted beyond the PEA and may be required to reimburse a portion of the PEA costs.

Site listing is the final step of the site evaluation phase. The Department is required pursuant to Section 25356 of the Health and Safety Code to prioritize and list all sites that require removal/remedial work. Information provided in the PEA report is used to prioritize sites for listing. Sites on the list are added to the site mitigation program's annual workplan when removal/remedial work will begin within the current fiscal year.

1.4 COST RECOVERY

California law requires the Department to recover all costs incurred by the Department associated with the investigation and cleanup of contaminated sites (HSC Section 25360). HSC Section 25343 authorizes the

assessment of a fee for overseeing the PEA investigation, developing the report and reviewing the final document. The current fee for oversight of a PEA is \$8,000¹; however, actual costs for the PEA investigation often exceed the fee amount. The final cost for oversight depends on the number of hours expended by Department staff. PEAs typically require 135 to 250 hours of Department staff time and range from 9 to 18 months from beginning to completion. The PEA fee is generally collected at the beginning of the project, and the actual cost that exceeds the PEA fee may be paid on a quarterly basis or at the end of the project. The method for final payment will depend on the type of agreement in place at the onset of the project.

1. \$8,000 is the amount from July 1, 1993 through June 30, 1994. The fee amount is adjusted annually to reflect increases or decreases in the cost-of-living, as measured by the Consumer Price Index issued by the Department of Labor or a successor agency of the United States Government.

CHAPTER TWO

THE PEA INVESTIGATION

Conducting a PEA investigation involves scoping the project, collecting and reviewing background information and chemical data, assessing community concern, and evaluating potential risks to public health and the environment. This chapter discusses methodologies for assessing the level of community interest in the site, identifies potential sources for locating information pertinent to the site investigation, provides procedures for acquiring reliable chemical data, and presents methodologies for completing screening level evaluations of human and ecological health risks related to site conditions.

2.1 SCOPING

The preface introduced the fact that the preparer has some flexibility regarding the focus of the PEA and the emphasis to be placed on each part of the investigation. Limits of this flexibility will be defined for each site by the Department's project manager through the scoping process. The preparer and project manager will scope activities to be performed to insure the activities are appropriate for site specific conditions and objectives. Scoping the activities to be performed aids in minimizing ineffective expenditure of time and money. The final report will document activities performed according to the manual and provide rationale for those PEA requirements not addressed.

2.1.1 SCOPING MEETING

The first step in conducting the PEA investigation is to hold a scoping meeting between Department staff, the party required to complete the PEA, and

professionals assigned to do the work. The purpose of the meeting is to agree upon a management approach for collecting information and develop a strategy for completing activities appropriate for the site. During the scoping meeting, plans should be made to identify:

- need for CEQA activities;
- a schedule for activities;
- roles and responsibilities between agencies and contract personnel;
- the level of information previously collected and assess the need for background research and data collection;
- public participation needs; and
- need for expedited response actions.

Scoping meetings are held throughout the investigation to review new information collected and/or update site strategy.

2.1.2 CONCEPTUAL SITE MODEL

In the past the Conceptual Site Model was introduced in the site mitigation process as an activity during the scoping phase of the Remedial Investigation/Feasibility Study (RI/FS). The PEA uses the model in the same manner by developing a preliminary understanding of the site's potential risks to human health and the environment. The Conceptual Site Model presents information about site conditions and potential impacts to receptors in a schematic presentation as shown in Figure 2.1. The preparer identifies the contamination sources and links them to potential receptors through release

mechanisms, potential pathways, and exposure routes. Identification of release mechanisms, pathways, and exposure routes provides rationale for sampling. The sampling plan can then be developed to determine the source of contamination, evaluate the migration potential and assess the exposure potential. Information regarding the use of a conceptual site model in the RI/FS is provided in the RI/FS and Data Quality Objectives guidance documents (USEPA, 1987a & 1988b).

2.2 PUBLIC PARTICIPATION

Public participation is an integral component of the site mitigation process. The Department's formal Public Participation Program establishes the mechanism for initiating and maintaining two-way communication between the community affected by a hazardous substance site and the regulatory agencies responsible for site investigation and cleanup. Solicitation of community concerns, suggestions, and comments throughout the site mitigation process allows the Department to make more informed decisions and reduces the potential for delays that might arise if the community objects to or does not understand an action or decision. It is the Department's policy that public participation activities be initiated from the onset of a project and continue throughout the entire site mitigation process.

2.2.1 COMMUNITY ASSESSMENT

Prior to beginning the initial assessment of community interest, the preparer and the Department's project manager and public participation staff must determine the need for public participation activities at the site. Sites where no PEA sample collection and no removal or remedial actions will occur may require no public participation activities at all. Each site must be evaluated individually for the site specific need. Once the need for public participation is

established, the preparer should begin the community assessment.

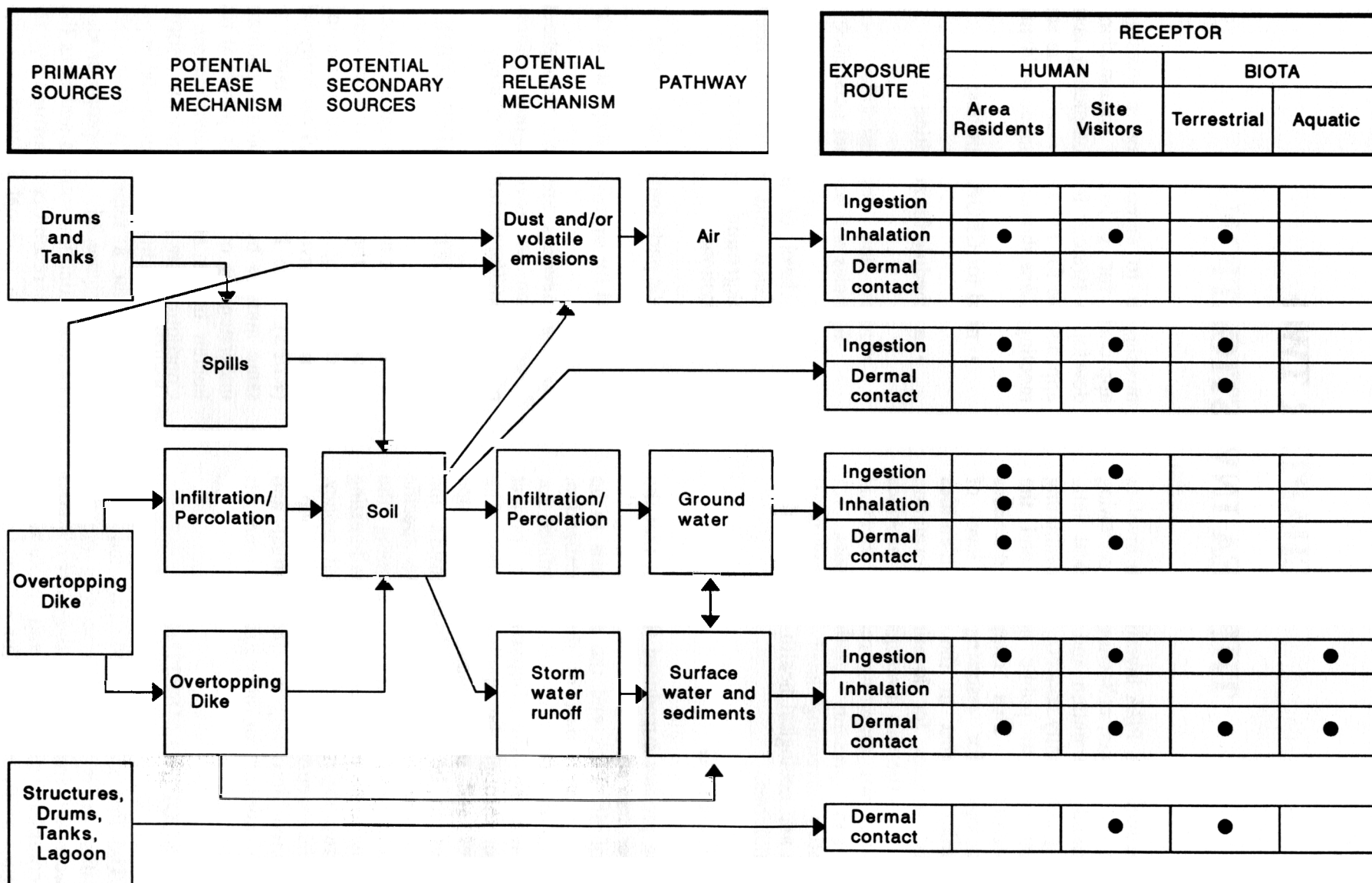
During the PEA process the preparer makes an initial assessment of community interest in the site to determine the appropriate mechanisms for establishing open lines of communication with the public. Activities such as public meetings, workshops, or fact sheets may be appropriate means for notifying all adjoining property owners, residents, and other concerned community members of the proposed PEA investigation activities and schedules. The magnitude of public participation activities conducted will differ from site to site and is generally greater at larger sites and sites in densely populated areas.

For the purpose of addressing community interest, the assessment should examine the level of the community's knowledge of the site; the types of community concerns; the proximity of the site to homes and/or schools, day care facilities, churches, etc.; the current and proposed use of the site; media interest (or likelihood of interest); involvement of community groups; and other factors deemed necessary by the Department. Information required to complete the assessment can be obtained from interviews with public officials, community groups, regulatory agency personnel, and persons familiar with the site.

The level of community interest will be used to determine the need for public notification of PEA activities and schedules. The degree to which public participation activities will be conducted will be determined by the Department's project manager and public participation staff. The preparer will submit recommendations for the types of notification activities to be performed. The recommendations should include information such as:

- Who will be notified of upcoming activities (include contact names, addresses, phone numbers);

FIGURE 2.1: CONCEPTUAL SITE MODEL DIAGRAM (USEPA 1988b)



A CONCEPTUAL SITE MODEL HELPS IDENTIFY POTENTIAL SOURCES, PATHWAYS, AND RECEPTORS WHICH MAY NEED TO BE ADDRESSED IN FIELD INVESTIGATIONS. KEEP IN MIND THAT DIFFERENT SITES HAVE DIFFERENT SOURCES, RELEASE MECHANISMS, AND PATHWAYS. AFTER CREATING THE LEFT SIDE WITH SITE SPECIFIC PATHWAYS, THE MODEL IS COMPLETED BY CHECKING THE APPROPRIATE RECEPTOR BOXES ON THE RIGHT.

- How information will be presented (e.g. workshops, fact sheets, public meetings, briefings for public officials, or other notification mechanisms);
- Determination of the need for non-English presentations or publications; and
- Schedules for presentation of the information.

2.2.2 COMMUNITY PROFILE

Information obtained during completion of the community assessment will be used to prepare a community profile. The community profile provides the basis for developing a formal community relations plan should further action be required at the site following completion of the PEA. Components of the community profile include:

- Summary of the community assessment including documentation of the level of community concern associated with the site;
- List of key contacts including federal, state and local officials; citizen groups; environmental groups; media contacts; and other interested parties;
- Potential locations for establishment of information repositories; and
- Information from public notification and other public comments.

The community profile is submitted to the Department for review and approval prior to initiation of field activities at the site. The profile will be used to determine the public notification activities to be conducted prior to the initiation of sampling activities at the site and during any remedial activities.

2.3 BACKGROUND RESEARCH

The purpose of the background research is to collect pertinent site information about the following:

- the site's location;
- regulatory status;
- physical and environmental characteristics;
- zoning;
- the current and historical land uses;
- facility operations;
- hazardous substance/waste management practices; and
- land use in immediate area that might influence onsite conditions.

At sites where information of past operations is limited, the type of operation known to have been conducted and any standard business or manufacturing practices applicable to operations of that kind and period should be researched.

Complete and accurate site information is essential for determining the apparent problem, the potential exposure pathways and receptors, and the sampling needs for the PEA investigation. It is recommended that records reviews, interviews, and site inspections be conducted to complete this information-gathering phase of the PEA investigation. The specific information to be collected during these activities is outlined in Sections 3.3.3 Site Description, 3.3.4 Background, and 3.3.6 Environmental Setting. The following sections provide guidance for completing these activities.

2.3.1 RECORDS REVIEW

This Section provides potential data sources for the information requested to complete the Background Research for the PEA. Not all of the sources listed need be explored for each PEA. The review should begin with

sources most likely to contain information on a given site.

1) **Agency Files:** The preparation of a complete history of onsite operations requires the review of all appropriate regulatory agency files. These files often provide documentation of hazardous substances releases and usually contain information not available in facility records. Each agency should be contacted by telephone prior to making a visit to review files. Appointments are often necessary and fees may be charged for copying.

a) **Department of Toxic Substances Control, Regional Office** for inspection results, permits, previous removal or cleanup activities, CalSites database identification number and HWIS database of manifest records.

b) **U.S. Environmental Protection Agency** for inspection results, permits, listing on the Federal CERCLIS, NPL, or RCRA TSD Facilities lists.

c) **Regional Water Quality Control Board** for waste discharge permits, previous cleanup activities, listing on landfill or solid waste disposal lists and state leaking or registered underground storage tank lists. (**Integrated Waste Management Board** may also have records concerning solid waste disposal.)

d) **County Offices** including Environmental Health Department; County Planning Department; Public Works Department; Air Pollution Control Districts; County Agriculture Commissioner's Office; County Tax Assessor's Office for all pertinent records regarding the site.

e) **Local Fire Department** for records regarding emergency response

activities and hazardous materials storage at the site.

f) **California Secretary of State's Office** for information regarding corporate ownership, officers, etc..

2) **Site Owner/Operator Records:** Facility records may be the primary source for information on hazardous substance/waste management practices at the site. Owner/operator files may include such records as product purchase invoices; waste manifests; permits; material safety data sheets; safety plans, preparedness and prevention plans; spill prevention, countermeasure and control plans; etc. that will provide valuable information regarding hazardous substance/waste types, quantities, and treatment, storage and disposal practices.

3) **Professional Trade Organizations:** These organizations will have information on manufacturing processes and common industry practices.

4) **Maps and Photographs:** Maps and photographs will be useful for establishing the physical setting of the site and identifying property uses at specified times.

a) **USGS 7.5 Minute Topographic Maps** produced by the United States Geological Survey provide a basis for establishing site location and topographic information.

b) **Aerial photographs** of areas encompassing the site may allow for identification of historical development or site activities.

c) **Photographs** may be available from private collections, libraries of local governments or colleges and universities, or historical societies that document historical site activities.

- d) **Fire Insurance Maps** produced by private fire insurance map companies indicate uses of properties at specified dates.

2.3.2 SITE INSPECTION

A site inspection is essential to document the physical setting of the site, verify information obtained from owner/operator and agency records, and/or obtain site specific information when no records are available. The site inspection should consist of a walk- through of known and potential exterior operations areas as well as the interiors of all structures. Observations during the site inspection should focus on identifying hazardous materials/waste management units, quantities and potential releases. The box to the right contains examples of the specific physical features the observer should attempt to identify.

2.3.3 INTERVIEWS

Interviews with current or former owners/operators, employees, occupants and/or site neighbors will be useful to obtain information regarding uses and historical physical characteristics of the site. Often based upon personal experience, this information can provide greater insight as to how the facility may have operated or who may be gaining access to the site. These personal accounts may confirm information found in agency files and provide missing details about the site. In some cases the information obtained from interviews may differ or contradict that obtained from records reviews. In these instances additional research may be required to determine which information is accurate. Notes taken during interviews may be used as reference documents.

Telephone interviews may also be conducted with State and local agencies to obtain information not readily available through file review, including drinking water

supplies, well locations, population served, and aquifer information.

- Property boundaries
- Locations and boundaries of all onsite operations (present and past)
- Foundations of former structures
- Storage tanks and storage areas (including "empty" drum storage)
- Odors
- Pools of liquid (including standing surface water)
- Electrical or hydraulic equipment known or likely to contain PCBs
- Unidentified substance containers
- Stained soil and pavement, corrosion, and degradation of floors and walls
- Drains and sumps
- Pits, ponds and lagoons
- Surface drainage pathways
- Stressed vegetation (from something other than insufficient water)
- Solid waste and waste water
- Wells (including dry wells, irrigation wells, injection wells)
- Septic systems

2.4 DATA COLLECTION AND EVALUATION

This section deals with collecting samples from the field and evaluating the quality of the data collected. The party conducting the PEA will meet with the Department project manager to review background

information collected and discuss the need for additional sampling and a sampling strategy for the site. The preparer will submit a proposed workplan to the Department for review and approval. Upon approval, the samples are collected and analyzed, and the resulting data is evaluated by the preparer and submitted to the Department for review. Once the sampling and quality objectives are met, the data is ready for use in the screening evaluation (Section 2.5) and preparation of the PEA report.

The scope and type of necessary field sampling will vary depending upon the site specific history and the nature of the release of hazardous substances. If sampling has been conducted in the past, the results and related information must be reported and evaluated as part of the PEA. Additional sampling activities are required for all PEA investigations unless prior sampling data is of sufficient quality and quantity to fulfill the PEA requirements and objectives and provides enough information to complete the PEA report. Past sampling activities must have been conducted in a manner consistent with Department standards and guidance in order to be used in lieu of additional PEA sampling activities. The Department's project manager will evaluate the adequacy of the data for use in the PEA investigation.

Prior to collecting samples for the PEA, it is important to identify and evaluate past sampling efforts to ensure that the PEA sampling efforts are planned and implemented appropriately. Some general PEA sampling objectives are provided in the box below. Site specific sampling objectives should be defined well in advance of collecting the samples.

- document whether a release of hazardous substances/wastes has occurred
- identify contamination "hot spots" that may require an expedited removal action
- provide data which allow a determination of the need to remediate the site
- provide input to PEA screening evaluation
- collect information for site listing process

2.4.1 WORKPLAN PREPARATION

The party preparing the PEA will be responsible for submitting a workplan for the Department's review and approval prior to implementing field activities. The workplan must include all information necessary for implementing field work. The workplan includes a Site Safety Plan (SSP) and a sampling plan. Requirements for the SSP are discussed in Section 2.4.4. The Department refers the preparer to USEPA guidance for suggested information and format for completing a sampling plan (USEPA 1990a). The following points are to be addressed in the sampling plan:

- 1) **Site Background:** Provide a history and site description relevant to sampling which identifies past activities which may have resulted in the contamination and the location and possible extent of the original release(s). The plan should also include other relevant site information such as topography, hydrology, climate conditions and past sampling information. Maps need to be presented that show the site in relation to its surroundings and identify site specific features. The plan should also include a map(s) dedicated to identifying all sampling points, contamination sources, surface water and general

ground water flow directions, and site boundaries.

- 2) **Rationale for sampling strategy:** Provide the reason for choosing the locations, number of samples, analytical parameters, detection limits and field screening methods. Any statistical approach used to select the locations should be explained.
- 3) **Sampling Methods:** List the standard operation method and step by step procedures of how each sample will be collected for each matrix and sampling techniques. Any special methods to prevent losses of volatile or unstable compounds should be described. All equipment used to obtain samples and number and type of field quality controls should be identified.
- 4) **Sample containers and preservation:** A table can be used to show types of containers and preservatives to be used for the different matrices and analyses. A description of or reference to the type of precleaning method used for the containers should be provided.
- 5) **Sample packaging and shipment:** Describe the methods for packaging, labeling, marking and shipping the samples.
- 6) **Sample documentation:** A description of the label with a photocopy example should be provided. A unique numbering system that positively identifies each sample and does not distinguish the quality assurance and quality control (QA/QC) samples from other samples should be described. There should be a discussion of field documentation to include field logs (log book, drilling logs etc.), photographs, and QC checklist or logs, and chain of custody forms and seals. The specific types of entries to be made in the various logs should be stated.

- 7) **Analysis Methods and Detection Limits:** List the analysis to be performed on each sample (group of samples) and the detection limit for each contaminant. The detection limit for a contaminant must be sufficiently low to insure that a significant threat does not go undetected (see Section 2.4.6.2).
- 8) **Decontamination:** A description of equipment decontamination and disposal of materials should be provided. While much of this discussion will be contained in the SSP, anything affecting the possibility of cross contamination should be included.
- 9) **Waste Management:** A description of the manner in which investigation derived wastes (drill cuttings, etc.) will be managed from containment to disposition.

2.4.2 SAMPLING STRATEGY

The primary objective of sampling during the PEA is to provide analytical data of known quality which identifies the contaminants at the site. This data will be used to estimate the risk to public health or the environment using the PEA screening evaluations. The PEA screening evaluations require the use of the highest concentrations of each contaminant detected on-site to estimate the site's potential threat. The sampling strategy should ensure that locations which would likely contain the highest contaminant concentrations will be sampled.

A secondary objective of the sampling is to determine the general extent of contamination in order to assess immediate potential threats and scope removal and remediation needs. Sufficient information should be gathered from the sampling to determine: 1) the need for expedited response actions such as restricting site access; 2) the areas of the site with highest levels of contamination; and 3) the priority

with which the Department should address final remediation.

The degree to which the sampling strategy includes surface soils, subsurface soils, ground water, surface water and air will be based on past hazardous materials handling practices, available analytical data, suspected contamination sources, probable migration routes, and potential exposure pathways identified in the conceptual site model. The extent of the subsurface investigation should be based on the site specific lithology and the migration potential of the contaminants. Overall, the investigation should be performed in a manner that will determine the nature of the contaminants, their general distribution in the environment and their potential to migrate.

The proposed sampling can occur in one event or can be addressed in a phased approach, depending on the information known prior to sampling and the specific goals of each investigation. Sites with little known and suspected contamination may require only one sampling event to gather sufficient information to address the objectives. Sites with extensive suspected contamination and numerous migration routes may require a phased approach with several sampling events. The phased approach may first determine the nature and general extent of soil contamination prior to determining the need for a ground water investigation, surface water sampling and/or air monitoring. The PEA preparer and Department staff should explore the most cost effective approaches to collecting the required information while maintaining the scientific integrity of the investigation.

Geologic or engineering plans, specifications, drawings, and reports must be prepared by, or under the direct supervision of a California registered geologist or civil engineer, as appropriate, who will review and sign all such documents indicating responsibility for their content.

2.4.2.1 SOIL SAMPLING (VADOSE ZONE)

The primary strategies used during the PEA to determine soil sampling locations are authoritative and systematic random sampling. Authoritative or "biased" sampling can be used to detect the highest concentrations of each contaminant and the general extent of contamination at sites where potential release locations are known. In this strategy the person collecting the samples selects the sampling locations using personal judgement; generally in areas where the highest concentrations of contaminants are suspected. Systematic random sampling can be used to determine the location and general extent of contamination at sites where the area of release is not well known. Systematic random sampling involves the collection of samples at predetermined, regular intervals of a grid placed over an area potentially impacted by a release. The reader should consult SW-846 (USEPA, 1986a) for more detail on the sampling strategies.

The PEA will require the collection of subsurface soil samples to assess the vertical extent of contamination and the potential for ground water contamination. The maximum depth of sampling will depend on the potential for migration of the contaminants through soil. Individual sample depths must be based on site specific lithology. Continuously cored boreholes must be installed to the anticipated depth of sampling at suspected locations of contamination. The continuous cores must be geologically logged and described for use in determining the depths at which samples are to be collected. Specifically, contacts between fine- and coarse-grained sedimentary units must be defined. Samples for analysis must be collected from fine-grained sediments occurring immediately adjacent to contacts with coarse-grained units. In the vadose zone fine-grained materials act as avenues for contaminant migration and may retard or

restrict the downward migration of contamination if it is moving by semi-saturated (or saturated) flow. Sampling locations should also be targeted at depths where information collected from direct reading instruments and physical observations indicate contamination may exist.

At most sites the samples collected and analyzed for the PEA are to be discrete samples. The compositing of samples loses information which would have been provided by the individual samples. Composite sampling is not recommended during the PEA, because the PEA usually involves relatively limited sampling, and each sample should provide as much information as possible. However, composite sampling can be approved by the Department in advance for very specific purposes.

At sites where volatile organic compounds (VOCs) are suspected, the use of soil gas sampling is recommended as an indicator for the presence and general extent of soil contamination and the potential for ground water contamination. After identifying the areas of concern via soil gas sampling, soil samples may be collected to obtain concentrations for use in the screening evaluation.

2.4.2.2 GROUND WATER SAMPLING

The determination whether ground water sampling is necessary at the site, including construction of monitoring wells, is based on a comparison of depth to local ground water and depth of soil contamination. Ground water sampling may not be necessary when contamination is known to be restricted to a few feet below the ground surface and ground water is a significant depth below ground surface. Subjective criteria can be used for some geologically well-characterized sites to make the decision not to install monitoring wells. For example, if the contaminants are relatively immobile and positively known to have been used or

disposed in relatively small quantities at the ground surface, monitoring wells are probably not necessary.

Ground water sampling should be performed at the site if any of the following conditions exist:

- Previous sampling data indicates that the ground water is contaminated;
- Historical operations at the site indicate a potential for ground water contamination due to quantity and/or types of chemicals released and the permeability of onsite soils; or
- Soil and/or soil gas data indicates the potential for ground water contamination.

When wells are required during the PEA investigation, a minimum of three monitoring wells are to be constructed with screened intervals across the water table. The purpose of monitoring wells is to identify through sampling if ground water has been affected by migration of contaminants and to establish the direction of ground water flow. In addition to sampling for suspected contaminants, monitoring wells should be sampled for water quality parameters and water level to check for fluctuations and obtain ground water elevation data not biased by short term aberrations, seasonal fluctuations, or off-site intermittent well pumping. These measurements are used to construct water contour maps, calculate gradients, and identify flow direction. Department general guidance on well installation and monitoring is available in Guidelines for Hydrogeologic Characterization of Hazardous Substance Release Sites (DTSC, 1993). Site-specific guidelines for the ground water monitoring program will be developed in conjunction with Department staff; including the construction of more than three monitoring wells.

Ground water monitoring for the PEA should continue until sufficient information is gathered to determine if ground water has been impacted. If initial monitoring results do not identify ground water contamination, the PEA report can be prepared with the recommendation that ground water monitoring continue (typically one year) to confirm the initial results. Results of the continued monitoring will be submitted to the Department for review. If these additional results do not indicate that contamination exists, monitoring may be discontinued. However, if results indicate contamination is present, the Department will retract the "no further action" recommendation for the ground water pathway and reopen the investigation.

If initial monitoring results identify significant ground water contamination, the PEA is concluded with a recommendation for further investigation and remediation. If the site will experience a time lag until the Department can provide oversight for characterization and remediation, monitoring should continue in the interim with results submitted to the Department and the RWQCB for review. This interim data will be very useful for scoping the RI/FS and/or for determining the site's relative priority for RWQCB oversight.

2.4.2.3 SURFACE WATER SAMPLING

Surface water bodies that pass through or border the site and have a potential to be affected by the contamination need to be sampled. Water and sediment samples should be taken to determine the up-gradient and down-gradient concentrations of chemicals. The methods used to collect samples, be they sediment or water, should be based upon the type of contaminants, type of water body, flow rate of water and other physical features. Sediment samples should be collected from locations where the potential exists for nonsoluble or slightly soluble contaminants to settle. Samples should be collected from various locations along the runoff course that leads from the contamination to the water body; at the

point where the runoff course enters the water body; up-gradient from that point; and down-gradient from that point.

2.4.2.4 AIR SAMPLING

The PEA determines the potential risk from contaminants via the air pathway by using the known contaminant concentrations in soil to estimate the probable concentrations in air. Air monitoring data are not appropriate for this screening evaluation because of the high degree of uncertainty in estimating long-term exposures from limited monitoring. Air monitoring can provide a synoptic estimation of air concentrations, and therefore may be useful for worker health and safety monitoring, or monitoring during removal actions.

2.4.2.5 BACKGROUND SAMPLING

Background samples are collected to distinguish between site related contamination and naturally occurring or anthropogenic contaminant levels. In general, the use of regional background levels for comparison to site contamination is not acceptable. Background samples should be collected for each medium being investigated, be it water, soil, soil gas, or air. Background samples should be collected at or near the site but not in areas likely to be influenced by the contamination and/or facility operations (past or present). Background samples should be collected from locations that are upgradient/upwind/upstream of the suspected contamination.

Background samples should be analyzed for naturally occurring chemicals. With few exceptions, one may assume that background levels for manmade chemicals are zero. The few exceptions may arise when an off-site source has contributed to the onsite contamination or the site is part of a regional contamination problem.

It is unlikely that a sufficient number of background samples will be collected during

the PEA investigation to be considered statistically valid. However, the information is useful in comparing relative ranges of background results to onsite contamination. We suggest background samples be collected from a minimum of four locations to determine the average contaminant concentration that is not a result of releases from the site. The collector should insure that the background samples at each location are collected from strata similar to onsite samples to which they will be compared. If initial sampling reveals a high variability between levels in each sample, more samples should be collected to increase the confidence in the average.

2.4.3 QUALITY ASSURANCE AND QUALITY CONTROL MEASURES

The sampling strategy for the site should include quality assurance and quality control (QA/QC) measures to be implemented as part of the sampling and analytical procedures. The purpose of these measures will be to produce data of a known quality. These QA/QC measures are established to monitor both field and laboratory procedures.

To check the precision and accuracy of field data, QA/QC samples will be collected for analysis. Field QC samples consist primarily of field blanks, trip blanks or

equipment blanks, duplicates, and split or collocated samples. Field quality control samples must be collected, stored, transported, and analyzed in a manner consistent with the site samples. Table 2-1 provides the minimum field QA/QC sample requirements for each medium. Samples to be used for QA/QC purposes should be collected from areas not likely to be highly contaminated.

In addition to samples listed in Table 2-1, QA/QC measures can be employed through-out the sample collection to improve the quality of the results. When selecting devices to collect, store, preserve and transport the samples, consider the effect the device may have on the integrity of the samples. The devices must not alter the samples so as to be reactive, promote adsorption, leach analytes, or otherwise influence contaminant concentrations prior to analysis. Sample collection should also be performed in a manner that does not adversely affect the sample integrity. The collected samples are to be representative of existing site conditions, and influences due to the sampling and analysis procedures should be minimized. In order to evaluate any potential influences, persons conducting the sampling should document the manner in which samples are handled from the time of collection until final analysis.

TABLE 2-1: QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

SAMPLE TYPE	RATIOS
Collocated replicates	5% of total # of samples
Split replicates	5% of total # of samples
Travel blanks	1 per sample shipment (volatiles)
Equipment blanks	1 per field decontamination event (as needed)

The State Certified laboratory performing the analysis should have its own internal QA/QC procedures. They include method blanks, surrogates, matrix spike and matrix

spike duplicates, laboratory duplicates and initial and continuing calibration checks. These procedures will more than likely vary between laboratories.

2.4.4 HEALTH AND SAFETY REQUIREMENTS

The Code of Federal Regulations (CFR) and the California Code of Regulations (CCR) describe requirements for health and safety at hazardous waste sites. Specifically, 29 CFR 1910.120 and 8 CCR 5192 require that:

- Personnel receive 40 hours of classroom training and 24 hours of supervised field training concerning the hazards that may be encountered at hazardous waste sites;
- Personnel participate in a medical monitoring program;
- A Site Safety Plan (SSP) be prepared prior to personnel entering a hazardous waste site; and
- Personnel review the SSP for specific hazards concerning the site prior to initiating work.

A SSP must be prepared and submitted to the Department for review prior to initiating PEA activities at the site. The SSP must be submitted to the Department in conjunction with the submittal of the Sampling Work Plan. The objective of the SSP is to ensure protection of the investigative team as well as the general public during PEA sampling activities.

ADDITIONAL REGULATORY REQUIREMENTS

The Department will provide oversight for the preparation and implementation of the majority of the work required to complete the PEA. However, in doing so, the Department does not relieve the responsible person(s) from liability for compliance with all other applicable laws and regulations. The PEA must be conducted in compliance with all applicable Federal, State and local requirements including, but not limited to

requirements to obtain permits and to ensure worker safety.

The following are some examples of other regulatory requirements whose applicability should be investigated prior to initiation of PEA sampling activities:

- County requirements for drilling permits and abandonment of borings and wells;
- Manifest and DOT requirements for transporting hazardous waste;
- Air Pollution Control District permit requirements for air emissions (e.g. from stockpiles of soils contaminated with volatile chemicals and for emissions during excavation);
- Regional Water Quality Control Board requirements for cleanup levels protective of ground water quality;
- OSHA requirements for worker safety;
- Land disposal restrictions for wastes/contaminated soils transported for disposal; and
- Department of Fish & Game requirements for identification and management of threatened or endangered species and habitats.

DATA EVALUATION

The PEA investigation usually requires the collection of a variety of data for a number of different purposes. Data collected can range from field monitoring data for health and safety precautions to laboratory analysis results to determine contaminant levels. Each sample collected may have been analyzed for a number of different chemicals, depending upon the rationale for the sample. However, not all of the chemicals detected will be attributable to an onsite release and not all of the data is guaranteed to be of an acceptable quality.

The purpose of the evaluation is to determine which of the chemicals identified by the data are likely to be site-related and to assess whether the reported concentrations for these chemicals are of acceptable quality for use in the screening evaluation. Much of the information in the following sections was excerpted from USEPA, 1989a.

2.4.6.1 EVALUATION OF ANALYTICAL METHODS

Not all of the data collected during the field investigation is appropriate for use in the screening evaluation. Analytical results that

are not specific for a particular compound or results of insensitive analytical methods (e.g., portable field instruments) generally are not appropriate for quantitative risk assessment. Table 2-2 provides examples of the types of analytical techniques and data that could potentially be unsuitable for use in the screening evaluation. These types of results, however, may be useful when considering sources of contamination, potential fate and transport of contaminants or qualitative discussions of risk. In addition, the results of analytical methods associated with unknown, few, or no QA/QC procedures should be eliminated from further quantitative use.

TABLE 2-2; EXAMPLES OF POTENTIALLY UNSUITABLE ANALYTICAL TECHNIQUES

Analytical Instrument or Method	Purpose of Analysis	Analytical Result
Photoionizing Detector	Health and Safety, Field Screen	Ionizable Organic Vapor
Organic Vapor Analyzer	Health and Safety, Field Screen	Total Organic Vapor
Combustible Gas Indicator with O ₂ meter	Health and Safety	Combustible Vapors, Oxygen-deficient Atmosphere
Field Gas Chromatography ¹	Field Screen/ Analytical Method	Specific Volatile and Semi-volatile Organic Chemicals

¹ Depending on the detector used, this instrument can be sufficiently sensitive to yield adequate data for use in a quantitative risk assessment; however, a confirming analysis by GC/MS should be performed on a subset of the samples in a laboratory prior to use. Source: EPA, Risk Assessment Guidance for Superfund, Volume I (Part A), December 1989.

2.4.6 EVALUATION OF DETECTION LIMITS

Before eliminating chemicals because they are not detected, the following points should be considered:

- the detection limit for a chemical may be greater than corresponding standards, criteria, or concentrations derived from toxicity reference values (therefore, the chemical may be present at levels greater than these corresponding reference concentrations, which may result in undetected risk); and
- a particular detection limit may be significantly higher than positively detected values in other samples in a data set.

These two points and types and definitions of detection limits are discussed in detail in Chapter 5 of USEPA, 1989a.

After considering the above points and any other reasonable reasons why contaminants may not have been detected, generally eliminate those chemicals that have not been detected in any medium. If information exists to indicate that the chemicals are present, they should not be eliminated. For example, if chemicals with similar fate and transport characteristics are detected frequently in soil, and some of these chemicals are also detected frequently in ground water while the others are not detected, then the undetected chemicals are probably present in the ground water and additional sampling should be conducted to attempt to confirm their presence. The PEA report can identify the possibility of undetected contaminants and recommend the additional sampling for the contaminants as part of the RI/FS.

2.4.6.3 EVALUATION OF QUALIFIED DATA

For analytical results, various qualifiers pertaining to the quality of the data are attached to certain data by either the laboratories conducting the analysis or by persons conducting the data evaluation. All qualifiers must be addressed before the chemical data can be used for the screening evaluation.

2.4.6.4 EVALUATION OF BLANKS

Analysis of blank samples provides a way to determine whether contamination has been introduced into a sample set either (1) in the field while the samples were being collected or transported to the laboratory or (2) in the laboratory during sample preparation and analysis. To prevent the inclusion of non-site-related contaminants in the screening evaluation, the concentrations of chemicals detected in blanks must be compared with concentrations of the same chemicals detected in site samples. Detailed definitions of different types of blanks are provided in Chapter 5 of USEPA, 1989.

Blanks containing common laboratory contaminants. Acetone, 2-butanone (or methyl ethyl ketone), methylene chloride, toluene, and the phthalate esters are considered by USEPA to be common laboratory contaminants (USEPA 1989a). In accordance with USEPA guidance (USEPA 1989a), if the blank contains detectable levels of common laboratory contaminants, then the sample results should be considered as positive results only if the concentrations in the sample exceed ten times the maximum amount detected in any blank. If the concentration of a common laboratory contaminant is less than ten times the concentration detected in the blank, then conclude that the chemical was not detected in the particular sample and consider the blank-related concentrations of the chemical to be the quantitation limit for the chemical in that

sample. Note that if all samples contain levels of a common laboratory contaminant that are less than ten times the level of contamination noted in the blank, then completely eliminate that chemical from use in the screening evaluation (the analysis results should still be presented in the report with an explanation).

Blanks containing chemicals that are not common laboratory contaminants. If the blank contains detectable levels of one or more organic or inorganic chemicals that are not considered by USEPA to be common laboratory contaminants, then consider site sample results as positive only if the concentration of the chemical in the site sample exceeds five times the maximum amount detected in any blank. Treat samples containing less than five times the amount in any blank as non-detects and consider the blank-related chemical concentration to be the quantitation limit for the chemical in that sample. Again, note that if all samples contain levels of a chemical that are less than five times the level of contamination noted in the blank, then completely eliminate that chemical from the set of sample results.

2.4.6.2 EVALUATION OF TENTATIVELY IDENTIFIED COMPOUNDS

Both the identity and reported concentration of a tentatively identified compound (TIC) are questionable. Two options for addressing TICs exist, depending on the relative number of TICs compared to non-TICs. A discussion of TICs is provided in Chapter 5 of USEPA, 1989a.

2.4.6.6 COMPARISON OF SITE DATA WITH BACKGROUND

In some cases, a comparison of sample concentrations with background concentrations is useful for identifying the non-site-related chemicals that are found at or near the site. If background risk might be

a concern, it should be calculated separately from site-related risk. A detailed discussion of background sample comparison is contained in Chapter 5 of USEPA, 1989a.

2.4.6.7 IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN

All chemicals that are not eliminated by any of the above evaluations should be considered potential contamination concerns for the site and should be evaluated further through the PEA screening evaluation. The preparer should work closely with Department staff when evaluating data that is thought to be non-site-related. Department approval is required before a chemical can be eliminated from evaluation through the human health screening evaluation described in the following section.

2.5 HUMAN HEALTH SCREENING EVALUATION

The purpose of this screening evaluation is to provide the risk manager with an estimate of the potential chronic health hazard from contamination at the site. The anticipated use of this screening evaluation is to assist the risk manager in deciding whether further site characterization, risk assessment, or remediation is necessary. The risk/hazard estimates are calculated for exposure pathways most frequently encountered at a residential setting. Due to the generic nature of these assumptions, the risk and hazard estimates are not absolute estimates of risk or hazard at a specific site. Although health-conservative exposure factors are used, not all potential exposure pathways are included (e.g. contaminant uptake by homegrown produce and subsequent ingestion). The Department is currently developing a multi-media, multi-pathway model (CalTOX) which can be used in a stochastic mode. The Department envisions that this screening evaluation will be

updated to include CalTOX once it has been formally adopted.

Because of the generic nature of the assumptions, the risk/hazard estimates calculated may not be maximum or "worst-case". It is the responsibility of the PEA preparer, in consultation with the risk manager, to determine whether additional exposure pathways should be considered. To assist the PEA preparer and risk manager, this guidance points out the assumptions and limitations of the models and equations.

This screening evaluation is intended to be a health-conservative preliminary evaluation of potential risk and hazard. This screening evaluation can be used to calculate preliminary remediation goals (PRGs) by establishing an accepted risk level or hazard quotient, and back calculating to a media concentration. However, the PRGs established by USEPA (USEPA, 1991b) cannot be used in lieu of this screening evaluation, since many of the exposure pathways considered in the screening evaluation are omitted from the calculation of PRGs.

PRGs are initial media concentrations to be used in the remedy selection phase of a feasibility study. Thus, PRGs are applied after considerable site investigation and site-specific risk assessment have been conducted. PRGs are for single compounds in one media; therefore, risk and hazard from multiple pathways and multiple compounds are not considered. In contrast, the screening evaluation is a set of equations designed to estimate hazard and risk for all compounds present at a site. The screening evaluation is to be applied early on in the site assessment process, typically before the exact extent of contamination has been fully delineated.

This screening evaluation consists of a compilation of methods, models, and assumptions commonly used by the USEPA to quantify risk/hazard. The approach used

in developing this screening evaluation was to define default exposure factors which must be used in the calculation of risk/hazard at each site. The default factors chosen are those recommended by the U.S. EPA to represent a reasonable maximum exposure in a residential setting at Superfund sites. Using these default factors, this screening evaluation quantifies the potential lifetime risk and hazard from site conditions for a defined set of exposure pathways. Use of these defined exposure parameters provides uniformity in the application of the screening evaluation, because little discretion is allowed on the part of the user in deciding which models, assumptions, and exposure factors to use.

2.5.1 SCREENING EVALUATION ASSUMPTIONS AND EXPOSURE FACTORS

The following sections outline the parameters of the human health screening evaluation. The use of alternative models and assumptions other than those stated herein is prohibited.

2.5.1.1 LAND USE

For purposes of this screening evaluation, the land use of the site will be assumed to be residential, regardless of the current use and zoning for the site. Additional evaluations and actions are necessary to address land uses other than residential. Therefore, alternative land use scenarios are beyond the scope of this screening procedure.

2.5.1.2 EXPOSURE PATHWAYS AND MEDIA OF EXPOSURE

It is assumed that the following exposure routes and media of exposure are applicable to residential land use:

Inhalation: airborne dust, VOCs from soils, VOCs from using household water;

Ingestion: surface water, ground water (household use only), and incidental ingestion of soil;

Dermal Absorption: direct contact with soil, surface water, and ground water (e.g., showering).

Other pathways of exposure are possible under a residential scenario, but for this screening evaluation, only these major pathways are considered. If food chain contamination is suspected or is plausible, then this screening level evaluation should not be used.

2.5.1.3 CHEMICAL GROUPS

Certain chemical groups are beyond the scope of this screening assessment since they require more complex toxicological evaluations or represent acute health risks. Examples would be wastes/soils which have a pH less than or equal to 2.0 or greater than or equal to 12.5; medical wastes; reactive/explosive wastes (e.g. munitions, strong oxidizers); asbestos and radioactive wastes. These wastes require other techniques of investigation and assessment.

The following assumptions should be used regarding certain chemicals and groups of chemicals:

1) Polycyclic Aromatic Hydrocarbons (PAHs):

(See Errata Sheet at end of Chapter 2.)

Assume all potentially carcinogenic PAHs are equivalent in cancer potency to benzo[a]pyrene on a weight basis, unless specified otherwise by the Cal/EPA. The following PAHs are considered to pose a potential carcinogenic risk to humans:

benzo[a]anthracene
benzo[b]fluoranthene
benzo[j]fluoranthene
benzo[k]fluoranthene
benzo[a]pyrene
chrysene

dibenz[a,h]acridine
dibenz[a,i]acridine
dibenz[a,h]anthracene
7H-dibenzo[c,g]carbazole
dibenzo[a,e]pyrene
dibenzo[a,h]pyrene
dibenzo[a,i]pyrene
dibenzo[a,l]pyrene
7,12-dimethylbenz[a]anthracene
indeno[1,2,3-c,d]pyrene
3-methylcholanthrene
5-methylchrysene

2) Polychlorinated Biphenyls (PCBs):

Assume all PCBs are equivalent to Aroclor 1260 in cancer potency.

3) Polychlorinated Dibenzo-p-dioxins and Dibenzofurans (PCDD/PCDF):

Assume unspciated PCDD/PCDF are equivalent in cancer potency to 2,3,7,8-tetrachloro-dibenzo-p-dioxin (2,3,7,8-TCDD). However, if congeners have been speciated, use the Interim Toxicity Equivalency Factor (I-TEF) approach (DTSC, 1992, Chapter 9).

4) Chromium: Assume total chromium is all hexavalent unless valid data on speciation are available.

5) DDT and Congeners: Assume the cancer potencies of DDE and DDD are equal to that of DDT.

6) Total Petroleum Hydrocarbons (TPH):

TPH values as such are not useful for this screening process. For analytical results reported as TPH in soil, the constituents to evaluate in this screening assessment are dependent upon the source of the TPH. If the source of petroleum hydrocarbons is known, or highly suspected to be, fuels or crude oil, then certain critical constituents of these petroleum products must be analyzed (e.g. heavy metals, PAHs, BTEX, etc.). The critical components will vary according to the fuel source. Oak Ridge National

Laboratory (1989) has published detailed information on various fuels.

If the source of the petroleum hydrocarbons is unknown, then a full scan for organic analytes should be conducted to identify the presence of critical constituents and their concentration prior to conducting the screening evaluation. Such a full scan for soils would include Methods 8240 and 8270 (USEPA, 1986b), while for water it would include Methods 624 and 625 (USEPA, 1982). These methods should be augmented as necessary with methods that achieve needed detection limits.

- 7) **Metals:** For the purposes of this document, the term "metals" is taken to include true metals, such as cadmium and zinc, as well as metalloid elements, such as arsenic and selenium.
- 8) **Inorganic Lead:** Evaluation of hazard from inorganic lead in soils is best conducted using a methodology not described here. For screening purposes, the Office of Scientific Affairs (OSA) has established that a concentration of inorganic lead concentrations less than 130 ppm in soil constitutes an acceptable human health risk. This value was obtained using the spreadsheet model LEADSPREAD, which is described in guidance from OSA (DTSC, 1992, Chapter 7) and conservative, screening level assumptions. If inorganic lead levels exceed 130 ppm in soil and exceed established background levels, then OSA guidance should be used to calculate hazard.
- 9) **Comparison to Background:** As described in Section 2.4.6.6, a comparison should be made to decide whether metal concentrations are comparable to background levels. Those metals present at levels equivalent to background need not be considered in the screening evaluation; however, metals whose concentrations

are above background should be included. Under no circumstances should background concentrations be subtracted from concentrations observed at the site. Lead may not be removed by comparison to background; it should be evaluated as described in (h) above.

2.5.1.4 EXPOSURE POINT CONCENTRATIONS

Use the maximum contaminant value which was found from sampling as the exposure point concentration. When using the models contained in the screening evaluation for estimating ambient air concentrations, use the maximum soil value found from sampling.

For chemicals which were treated or stored on site, or for chemicals which are suspected to have been spilled on the site but sample data indicate the contaminant concentration is below the sample quantification limit (SQL, a.k.a. practical quantification limit or PQL), then the value of the SQL is to be used as the exposure point concentration.

In cases where there is adequate characterization, and subject to review and approval by the project manager at the Department's Regional office, the 95 percent upper confidence limit of the arithmetic mean may be used for the exposure point concentration. If a concentration other than the maximum value observed is employed, consult DTSC (1992), Chapter 2, for details of calculations.

2.5.1.5 TOXICITY VALUES

The hierarchy of toxicity values to be used in the preliminary assessment is as follows:

- 1) Cancer potency factors (slope factors, SFs) or chronic reference doses (RfDs) promulgated into California regulations.

- 2) SFs or chronic RfDs used to develop environmental criteria promulgated into California regulations.
- 3) USEPA's Integrated Risk Information System (IRIS). Access to this database can be obtained through the National Library of Medicine's "TOXNET" system, (301)496-6531; USEPA's Risk Information Hotline, (513)569-7254; or a variety of commercially available databases.
- 4) The most current edition of USEPA's Health Effects Assessment Summary Tables (HEAST). Copies of this document may be ordered through National Technical Information Service in Springfield, Virginia, (800)553-6847.
- 5) Toxicity values for compounds not available in references 1) through 4) should be obtained by contacting the OSA "Helpline", at (916)255-2007. The PEA preparer must provide OSA with the site name, name of the Department's project manager, chemical name(s) and Chemical Abstracts Service Registry Number(s), type of media contaminated, and routes of exposure.

References 1) and 2) above include SFs or RfDs used in deriving the "no significant risk levels" under the State's Safe Drinking Water and Toxic Enforcement Act of 1986 and SFs or RfDs used in deriving State drinking water Maximum Contaminant Levels (MCLs). The entirely health-based dose criteria should be used to estimate risk and not the resulting risk management environmental concentration criteria (e.g., not the MCL). Cal/EPA Criteria for Carcinogens (Cal/EPA, June 18, 1992) is updated annually. Copies may be obtained from the Department's project manager for the site or from the Office of Environmental Health Hazard Assessment, (916)324-7572.

Use categories (c) and (d) when State SF or chronic RfD values are not available.

Chronic (not subchronic) RfDs must be used to calculate hazard.

When determining the toxicity value for inhalation pathways, use an inhalation reference concentration (RfC) when available. The RfC, expressed in mg/m^3 , should be converted to equivalent RfD values (in units of dose) by multiplying the RfC by a ventilation rate of $20 \text{ m}^3/\text{day}$ and dividing it by an average body weight of 70 kg [$\text{RfC} (\text{mg}/\text{m}^3) \times (20 \text{ m}^3/\text{day} / 70 \text{ kg}) = \text{RfD} (\text{mg}/\text{kg}\text{-day})$]. When an inhalation SF or RfC is not available for a compound, use the oral SF or RfD in its place.

Use oral SFs and RfDs as surrogate values to estimate systemic toxicity as a result of dermal absorption of a chemical, because dermal toxicity values are currently not available for any chemicals. Use of the oral SF or oral RfD directly does not correct for differences in absorption and metabolism between the oral and dermal routes. Also, direct toxic effects on the skin are not accounted for. Thus, the use of an oral SF or oral RfD for the dermal route may lead to an underestimation or an overestimation of the risk or hazard, depending on the compound. Therefore, the use of the oral toxicity value as a surrogate for a dermal value increases the uncertainty in the estimation of risk and hazard. However, this is not generally expected to significantly underestimate the risk or hazard relative to the other routes of exposure evaluated in this risk assessment screening procedure.

2.5.2 RISK/HAZARD CHARACTERIZATION

For each compound detected at the site, the screening evaluation calculates a risk and/or hazard for water, soil, and air pathways. The excess lifetime cancer risk for carcinogenic compounds (termed "Risk_i" where "i" is the medium of exposure (water, soil, air)), is calculated only for those compounds considered by Cal/EPA or USEPA to pose a carcinogenic risk to humans. This value represents the risk, or

theoretical probability, of developing cancer from that chemical upon exposure to that medium. The hazard quotient (termed "Hazard_i" where "i" is the medium of exposure), is calculated for all compounds, carcinogenic as well as non-carcinogenic. This value is a measure of the non-carcinogenic toxicity of a compound; it is not a probability. The hazard quotient is the ratio of the estimated dose from exposure to compounds in a medium, to a value which is believed not to produce adverse health effects.

The equations listed in Figures 2.2, 2.3, and 2.4 are the risk and hazard equations which have been simplified by incorporating the default values (USEPA, 1991a; DTSC, 1992, Chapter 1) to achieve a reasonable maximum estimation of exposure in a residential setting. These are the primary equations to be used to calculate the risk and hazard for each pathway (water, soil, and air). The original equations and default factors used to develop the simplified equations are in Figures 1 through 8 in Appendix B. The equations for risk and hazard use the same default factors, except for the averaging time (AT). AT is 70 yr for cancer risk, but is set equal to 6 years for non-carcinogenic hazard to be consistent with the exposure duration for non-carcinogenic hazards. Thus, all non-carcinogenic exposures are estimated for a child, which are the receptors with the greatest estimated exposures. The risk/hazard equations were simplified to a pathway exposure factor and three variables: the chemical-specific toxicity value (SF or RfD), the concentration of the chemical in the medium (C), and a dermal bioavailability term (K_p or ABS).

The equations used for the water pathway (Figure 2.2) and for the air pathway (Figures 2.4 through 2.8) differ for VOCs and non-VOCs. For the purposes of this screening evaluation, a chemical is considered to be volatile (VOC) if it has a vapor pressure greater than 1×10^{-3} mm Hg or a Henry's Law Constant (H) greater than 1×10^{-5} atm-

m³/mole. A chemical with values less than or equal to these are considered non-volatile (non-VOCs).

SELECTION OF PATHWAYS

The soil and air risk/hazard estimates must be calculated for all sites; however, the water risk/hazard estimate may not apply at all sites. The assessment of the potential impact that onsite contamination may have on surface and ground water is complex and will vary with site specific conditions. Department staff and private parties conducting the investigation will use best professional judgement and information gathered during the scoping and data collection phases of the investigation to assess the potential impact on water resources. The results of this assessment will determine the need to calculate the water risk/hazard estimate. A detailed rationale for eliminating the water pathway must be provided in the PEA report.

The following are potential assessment results and the required risk/hazard calculations for each:

- 1) At sites with limited soil contamination, the Department may determine that the contaminants will not impact surface water or the water bearing zone, now or in the future. In these cases the risk/hazard from water exposure need not be calculated. Calculation of the risk/hazard from soil and air will suffice.
- 2) When the characterization of surface or ground water contamination is adequate and the available water data is likely to represent the maximum concentrations of the contaminants, then the risk/hazard from water, soil, and air should be calculated.
- 3) When an acknowledged potential (which requires further investigation) exists for surface or ground water to be impacted by onsite contaminants, and available data on water does not fully represent

the nature and extent of the contamination, then the risk/hazard from water, soil, and air should be calculated. A qualifying statement should then be included to indicate clearly that the estimate of risk/hazard is based on data from water that may not represent the maximum contaminant concentrations present.

- 4) When site specific information is insufficient to judge the potential impact

of contaminants on surface and ground water, then the calculation of risk/hazard cannot proceed, because the resulting estimates may not reflect the potential risk/hazard posed by onsite contamination. In these instances the scoping and data collection phases of the investigation should be reviewed to determine the potential for conducting additional work to gather the information necessary to complete the calculations.

FIGURE 2.2: CALCULATION OF RISK/HAZARD FOR WATER

1. Risk for Non-VOCs

$$\text{Risk}_{\text{water}} = (\text{SF}_o \times C_w \times 0.0149) + (\text{SF}_o \times C_w \times 0.0325 \times K_p)$$

2. Risk for VOCs

$$\begin{aligned} \text{Risk}_{\text{water}} = & (\text{SF}_o \times C_w \times 0.0149) + (\text{SF}_i \times C_w \times 0.0149) \\ & + (\text{SF}_o \times C_w \times 0.0325 \times K_p) \end{aligned}$$

3. Hazard for Non-VOCs

$$\text{Hazard}_{\text{water}} = ((C_w/\text{RfD}_o) \times 0.0639) + ((C_w/\text{RfD}_o) \times 0.0644 \times K_p)$$

4. Hazard for VOCs

$$\begin{aligned} \text{Hazard}_{\text{water}} = & (C_w/\text{RfD}_o) \times 0.0639 + (C_w/\text{RfD}_i) \times 0.0639 \\ & + ((C_w/\text{RfD}_o) \times 0.0644 \times K_p) \end{aligned}$$

Where:

SF_o = oral cancer potency slope, $(\text{mg/kg-day})^{-1}$

SF_i = inhalation cancer potency slope, $(\text{mg/kg-day})^{-1}$

C_w = concentration in surface or ground water, mg/L

RfD_o = oral reference dose, mg/kg-day

RfD_i = inhalation reference dose, mg/kg-day.

K_p = the chemical-specific dermal permeability coefficient from water.^a

a. Refer to Table 1 in Appendix A (USEPA, 1992, Table 5-7) for the chemical-specific value for organic compounds. If the chemical of concern is not in Table 1, then use a value for a chemical in the Table with similar molecular weight and K_{ow} values.

FIGURE 2.3: CALCULATION OF RISK/HAZARD FOR SOIL

$$\text{Risk}_{\text{soil}} = (\text{SF}_o \times \text{C}_s \times (1.57 \times 10^{-6})) \\ + (\text{SF}_o \times \text{C}_s \times (1.87 \times 10^{-5}) \times \text{ABS})$$

$$\text{Hazard}_{\text{soil}} = ((\text{C}_s/\text{RfD}_o) \times (1.28 \times 10^{-5})) \\ + ((\text{C}_s/\text{RfD}_o) \times (1.28 \times 10^{-4}) \times \text{ABS})$$

Where:

SF_o = oral cancer slope factor, (mg/kg-day)⁻¹

C_s = concentration in soil, mg/kg

RfD_o = oral reference dose, in units of mg/kg-day.

ABS = absorption fraction, dimensionless^a.

a. Refer to Table 2 in Appendix A for the absorption fraction value based on class of compound. For purposes of this document, the term "metals" is taken to include true metals such as cadmium and zinc, as well as metalloid elements, such as arsenic and selenium.

FIGURE 2.4: CALCULATION OF RISK/HAZARD FOR AIR

$$\text{Risk}_a = \text{SF}_i \times \text{C}_a \times 0.149$$

$$\text{Hazard}_a = (\text{C}_a/\text{RfD}_i) \times 0.639$$

Where:

SF_i = inhalation cancer slope factor, $(\text{mg/kg-day})^{-1}$

RfD_i = the inhalation reference dose, mg/kg-day .

C_a = concentration in air, mg/m^3

The value for C_a is estimated using Figures 2.5, 2.6 & 2.7 for VOCs and Figure 2.8 for non-VOCs.

2.5.2.2 WATER PATHWAY

If water is a pathway for the site, use the equations in Figure 2.2 to calculate the risk and hazard from this pathway. The risk calculated is a summation of ingestion exposure, inhalation of VOCs released from water used indoors, and dermal exposure for child and adult. However, hazard is calculated only for the first 6 years of childhood. If the hazard index is not exceeded for the child, it will not be exceeded for any other age. These equations do not include exposure from ingestion of aquatic organisms in surface water.

2.5.2.3 SOIL PATHWAY

Use the equations in Figure 2.3 to calculate the risk and hazard for the soil pathway. The risk calculated is a summation of the incidental soil ingestion exposure for a child and an adult and the dermal exposure for a child and an adult. However, hazard is calculated only for the first 6 years of

childhood. If the hazard index is not exceeded for the child, it will not be exceeded for any other age. The equations do not include exposure from ingestion of homegrown fruits and vegetables, or products from animal (e.g., meat, milk, eggs) that feed on vegetation grown on contaminated soil.

2.5.2.4 AIR PATHWAY

The risk and hazard for the air pathway are based on either the exposure to volatile emissions for VOCs or the exposure to fugitive dust emissions for non-VOCs. OSA has performed extensive modeling assuming contaminants are present in respirable dust at the respective weight fractions as in site soils, assuming the default value of $50 \mu\text{g/m}^3$ for respirable dust in air, and defining a VOC as a chemical with a vapor pressure of 0.001 mm Hg or higher and a Henry's Law constant of 1×10^{-5} or higher. Results showed that using either volatilization or fugitive dust

adequately describes exposure to a chemical; it is not necessary to do both.

For VOCs the volatilization of compounds generated from contaminated soils is the only pathway considered. Volatilization of contaminants into household air during water usage is accounted for in the water exposure equation. For non-VOCs, the fugitive dust model is not applicable for areas where the air quality standard of $50 \mu\text{g}/\text{m}^3$ for particulates is routinely exceeded, nor is it applicable for assessing contaminant fibers such as asbestos.

The VOC emission model does not consider exposure to soil-gas vapors generated from contaminated shallow groundwater. Enhanced volatilization of compounds due to generation of landfill gases is also not considered. The emission model does not account for construction-related factors which would act to enhance VOC movement indoors (e.g., construction of certain energy efficient homes). If site-specific information indicates these additional transport mechanisms are potentially significant, more sophisticated transport models are needed.

The risk/hazard equations for both VOCs and non-VOCs are presented in their simplified forms in Figure 2.4. The calculated risk is based on childhood and adult exposure. Hazard is calculated only for the first 6 years of childhood. If the hazard index is not exceeded for the child, it will not be exceeded for any other age. The chemical concentration in air must be estimated using Figures 2.5, 2.6 and 2.7 for VOCs and Figure 2.8 for non-VOCs. Air monitoring data should not be used for this screening evaluation, since such data provide a synoptic view under conditions limited to the monitoring period, and thus are not appropriate for estimating long-term exposures.

Monitoring data are useful for worker health and safety monitoring and monitoring during removal actions.

2.5.2.5 ESTIMATION OF AIR CONCENTRATION

For VOCs use the equations in Figures 2.5 and 2.6 to estimate volatile emissions from soil for each chemical. First calculate the saturation concentration (C_{sat}) for the compound using the equations in Figure 2.5. If the concentration in the soil is greater than the saturation concentration, this screening procedure cannot be used, because the emission model given in Figure 2.6 would no longer be valid. If site concentrations exceed C_{sat} , then free product or liquid probably exists in soil. Such a liquid might constitute a threat to ground water.

The VOC emission model is recommended by USEPA (1991;1992b). The model has been partially validated by USEPA (1992c) and recommended modifications (Dinan, 1992) have been incorporated here into the equation shown in Figure 2.6. OSA has altered some of the default values for model parameters (i.e., surface area, organic carbon content of the soil, and exposure interval) to coincide more closely with expected residential conditions in California. Emission rates are calculated over the minimum dimensions of a residential lot in California, 5,000 square feet or 484 m^2 (Hadley and Sedman, 1990). The equation in Figure 2.6 shows all the default parameters and unit conversions in a simplified form. The complete equation along with default values can be found in Appendix B.

The equation in Figure 2.6 is not applicable where municipal or sanitary wastes have been disposed with the hazardous substances, since decomposition of the solid waste would

generate landfill gases which can greatly enhance volatile emission rates. This equation is also inapplicable if shallow ground water is contaminated with VOCs, because this condition could permit additional vapors to be released and transported upward through soil to reach ambient air.

The box model shown in Figure 2.7 (Hwang and Falco, 1986; USEPA, 1991, 1992b) is used to provide an estimate of ambient air concentration using the total emission rate calculated above. The length dimensions of the hypothetical box within which mixing will occur is based on the minimum dimensions of a residential lot in California (22 meters; all other parameters are as cited in USEPA 1991;1992b).

For non-VOCs use the equation in Figure 2.8 to estimate the contaminant concentration in air from fugitive dust emissions.

2.5.2.6 SUMMATION OF RISK/HAZARD FOR ALL MEDIA

For cancer risk, sum risks from each carcinogen over all exposure media and for all carcinogens to obtain the total excess lifetime cancer risk posed by the contaminants at the site. For hazard, sum the hazard quotients from each compound over all exposure media and for all chemicals to obtain the total hazard index posed by the contaminants at the site. For screening purposes, this simplifies the calculation of hazard quotient by disregarding the toxic manifestation/target organ affected by each compound. If this hazard quotient is greater than 1, then the hazard quotient should be recalculated by only summing exposure to all media for chemicals which have the same toxic manifestation or effect the same target organ. OSA ((916)255-1007) must be contacted for guidance in grouping compounds.

In general, a risk estimation greater than 10^{-6} or a hazard index greater than 1 indicate the presence of contamination which may pose a significant threat to human health. Exceptions will generally include sites with elevated background concentrations, sites where other agency criteria are more stringent, and sites with specific circumstances that allow for a risk management decision to elevate the acceptable screening levels. The latter of these must be discussed with OSA and all must be approved by the Department's project manager.

2.5.2.7 UNCERTAINTY ANALYSIS

As an option, the PEA report may contain a section qualitatively discussing uncertainties in the human health screening evaluation. This discussion should not debate the validity of the default exposure factors since such factors are generic to assumed behavioral and physiological factors appropriate for humans in a residential setting (e.g., soil ingestion rates for a child). The uncertainty section instead should focus on specific site conditions which contribute most significantly to uncertainty in the risk and hazards estimates. Reliance on the information presented in the uncertainty analysis to decide "no further action", when the screening evaluation estimates risk greater than 10^{-6} or a hazard index greater than 1, warrants discussions with OSA staff.

A quantitative or stochastic uncertainty analysis should not be presented, as such an analysis is beyond the scope of a screening evaluation, and is more appropriate in a full baseline risk assessment. An in-depth uncertainty analysis is of no value in a screening evaluation when the outcome of the PEA process is binary, i.e., whether further action of investigation is warranted.

FIGURE 2.5: CALCULATION OF SATURATION CONCENTRATION FOR VOCs

$$C_{\text{sat}} = \frac{S \times (0.15K_d + 0.015 + 1.16 H_c)}{1.5}$$

If the concentration of the contaminant in the soil is greater than C_{sat} , then the equation given in Figure 2.6 is not valid, and the calculation of volatile emissions is beyond the scope of this screening evaluation

Where:

C_{sat} = Saturation concentration, mg/kg

K_d = soil/water partition coefficient, cm^3/g
(=L-water/kg-soil)
= $K_{\text{oc}} \times f_{\text{oc}}$

Where:

K_{oc} = organic carbon partition
(refer to Table 3, Appendix A^a)
 f_{oc} = fraction of organic carbon (default = 0.02)

S = solubility of contaminant in water, mg/L-water
(refer to Table 3, Appendix A)

H_c = Henry's Law Constant, $\text{atm}\cdot\text{m}^3/\text{mole}$
(refer to Table 3, Appendix A)

a. If the K_{oc} is not available in Table 3 of Appendix A, refer to Appendix B, Step 1 for the appropriate equation.

Note: The above equation incorporates the default parameters and unit conversion factors. Refer to Appendix B for the complete equation and derivation of this simplified equation.

(NOTE for figure 2.5: see Errata Sheet at end of Chapter 2.)

FIGURE 2.6: CALCULATION OF EMISSION RATE FOR VOCs

$$E_i = \frac{1.6 \times 10^5 \times D_i \times \frac{H_c}{K_d} \times C_i}{\sqrt{D_i \times \frac{0.023}{0.284 + 0.046 \times \frac{K_d}{H_c}}}}$$

Where:

- E_i = average emission rate of contaminant i over the residential lot during the exposure interval, mg/sec
- D_i = diffusivity in air for compound i, cm²/sec (refer to Table 3, Appendix A)
- H_c = Henry's Law constant, atm-m³/mole (refer to Table 3, Appendix A)
- K_d = soil-water partition coefficient, cm³/g; calculated in Figure 2.5
- C_i = bulk soil concentration of contaminant i; (chemical concentration in soil, mg/kg, x (10⁻⁶ kg/mg))

Note: The above equation includes unit conversion factors for the various parameters. Refer to Appendix B, Step 2 of the Volatile Emission Model for the complete equation and derivation of the condensed equation.

FIGURE 2.7: ESTIMATION OF AIR CONCENTRATION FOR VOCs

Equation:

$$C_a = E_i / 99$$

Where:

C_a = ambient air concentration, mg/m³

E_i = total emission rate for compound i (mg/second);

Derivation:

$$C_a = \frac{E}{LS \times V \times MH}$$

E = emission rate over residential lot (mg/sec)

LS = length dimension perpendicular to the wind (m)
(default value = 22 m, one side of a square lot 484 m² in area)

V = average wind speed within the mixing zone (m/sec)
(default value = 2.25 m/sec)

MH = mixing height (m) (default value = 2 m)

Therefore:

$$C_a = E / 99$$

FIGURE 2.8: ESTIMATION OF AIR CONCENTRATION FOR non-VOCs

Equation:

$$C_a = C_s \times (5 \times 10^{-8} \text{ kg/m}^3)$$

Where:

C_a = concentration in air, mg/m^3

C_s = concentration in soil, mg/kg .

Derivation:

$$C_a = C_s \times 0.05 \text{ mg/m}^3 \times (1 \times 10^{-6} \text{ kg / mg})$$

For screening purposes, it is assumed that ambient air particulates are equal to the National Ambient Air Quality Standard for the annual average respirable portion (PM_{10}) of suspended particulate matter of $50 \mu\text{g/m}^3$ (0.05 mg/m^3) (USEPA, 1993), and the screening-level assumption is made that 100% of the particulates have the same contaminant concentration (non-VOCs only) as the maximum soil value. It should be noted that this estimation procedure is not applicable to a site which is particularly dusty, i.e. the air quality standard for suspended particulate matter is routinely exceeded. This approach is also not applicable to contaminant fibers, such as asbestos.

Therefore:

$$C_a = C_s \times (5 \times 10^{-8} \text{ kg/m}^3)$$

2.6 ECOLOGICAL SCREENING EVALUATION

The ecological screening evaluation adopts the basic approach suggested by USEPA (1989d,1992d); however, the evaluation is qualitative rather than quantitative. The ecological screening evaluation relies on the professional judgement of the preparer to qualitatively evaluate the potential risk to non-human receptors posed by contaminants from practices on the site. The preparer cannot assume that the human health screening evaluation provides an estimate of the threat to biota. The term "biota" excludes humans, and generally refers to nondomesticated terrestrial and aquatic plants and animals, but can also include domesticated species, such as livestock.

The approach used in the screening-level ecological evaluation is to identify exposure pathways between the areas of contamination and biota or habitats which occupy or potentially could occupy the site, or areas affected by the site. If there are possible exposure pathways, further site investigation and assessment may be warranted.

2.6.1 SITE CHARACTERIZATION

The chemical and physical characterization of the site is similar to that needed to support a human health screening evaluation. However, certain aspects such as contamination of plants and sediments may require additional investigation. Particular attention should be given to identification of chemicals of concern to biota, since a chemical not generally considered a threat to human health may be a chemical of concern for biota. For example, ammonia, copper, cadmium, chromium, selenium, silver, lead, zinc, nickel, toluene, xylene, and

other chemicals may have adverse effects on aquatic organisms at concentrations lower than would be of concern for humans. Exposure pathways for terrestrial organisms are more varied and complex than for aquatic organisms so it is difficult to list specific chemicals, but in general, organophosphates, carbamates, organochlorine pesticides, herbicides, and PCBs may be of concern to terrestrial organisms at lower concentrations than for humans. In addition, many organisms, because of their life history, may be exposed to higher concentrations of contaminants than humans. An example would be burrowing animals' exposure to soil gases.

The range of contaminants, the maximum and minimum concentrations of these contaminants and any information on habitat-specificity of contamination should be presented in a table. A table of potential contaminants and potential distribution based on known or suspected use must be included if chemical analyses are not completed as part of the ecological screening.

2.6.2 BIOLOGICAL CHARACTERIZATION

A biological characterization of the site, conducted by a qualified field biologist, is needed to identify the biota actually or potentially occurring at the site. Advance notice of the date and time of the site survey to concerned regulatory agencies should be considered when appropriate.

The site survey should allow identification and determination of the extent of coverage of site-specific habitats. Off-site habitats that may be affected by site-related contamination

must also be evaluated. Marine or estuarine habitats should be evaluated in terms of both the water and sediment components. Terrestrial habitats such as forest, oak woodland, grasslands, Jepson prairie, vernal pools, riparian, lacustrine, palustrine, desert, sand dune, coastal chaparral, agricultural or maintained landscape such as golf courses should be evaluated and characterized. Transition zone habitats such as freshwater wetlands, saltwater wetlands, brackish water wetlands, marine intertidal and mudflats of rivers, lakes or streams should be evaluated and characterized. Biological characterization of the site should also identify the species and types of communities potentially occurring due to their occurrence at nearby areas (i.e., within 1 mile). The location of all wildlife areas, preserves, reserves, sanctuaries, parks, natural areas, conservation areas, or other protected areas within 1 mile of the site should also be identified.

Particular emphasis should be placed on identification of "special species" and their habitats which occur on or within a one-mile radius of the site. Special species include California species of special concern; state and federally listed rare, threatened or endangered species; species which are proposed or recommended for state or federal listing. The California Department of Fish and Game's (DFG) Natural Heritage Division can be contacted for the current special animal and special plant lists. The DFG's Natural Diversity Data Base (NDDDB) can be a starting point for location information on special species which have been found near the site; although the NDDDB is not an all-inclusive listing. For more information on special plant and animal lists and the NDDDB, contact:

Information Services Coordinators
Information Services
Natural Heritage Division

California Dept. of Fish and Game
1416 9th St., 12th floor
Sacramento, CA 95814
(916)324-3812 or (916)327-5960

In lieu of an extensive site-specific biological survey conducted over an extended period of time to identify species occupying each distinct habitat, the species expected to occupy each habitat can be identified. In such an instance, a qualified field biologist would first identify each distinct habitat occupying the site and the surrounding area within 1 mile (include identification of locations where contaminants may be transported). Then the species which can be expected to occupy those habitats can be identified based on the literature. Examples of useful literature sources include Airola, 1988; Mayer and Laudenslayer, 1988; Zeiner, et al., 1991. These references are available for purchase from Wildlife Habitat Relationship Coordinator, California Department of Fish and Game, (916)657-3933. These references also provide summary information on food items, life history, and habitat requirements for many species found in California.

2.6.3 PATHWAY ASSESSMENT

Once potential species and habitats are identified, a pathway assessment is conducted. Pathway assessment identifies the potential for contact between biota and chemicals of concern in any medium and by any route. Media to be considered include soil, air, water, and biota. Physical and chemical characteristics which influence environmental fate and transport must be considered. In particular, off-site transport of contaminants must be evaluated, e.g. surface drainage pathways. Pathways may be direct, such as inhalation of air, or indirect, such as movement through the food web. Exposure routes to be considered

include inhalation, ingestion, and dermal contact. Pathways shall be considered complete unless the chemical will not enter the medium or the receptor will not contact the medium, either directly or indirectly, now or in the future. A qualitative description of the magnitude, duration and frequency of exposure to the various biological receptors, representing multiple trophic levels, for each contaminant or area of contamination, should be provided. A tabular summary of the exposure pathway analysis for each habitat type, as depicted in Table 4, Appendix A, should be provided. Such an exposure pathway analysis is an expansion of the site conceptual model developed in Figure 2.1.

2.6.4 QUALITATIVE SUMMARY

A site-wide habitat map is required as part of the ecological screening. All major habitats should be displayed on a map equivalent to a USGS quadrangle map (1:25000). Separate indication of the coverage of tree canopy, shrubs or dominant herbaceous plants may be appropriate. A site-wide map of similar dimension should indicate historical land use patterns, particularly those land uses which may have resulted in release of hazardous substances. Current land use which differs from historical land use must be indicated. Location of former landfills, wastepiles, material stockpiles, burn pits, surface impoundments, firing ranges, strafing or bombing ranges, hazardous waste storage areas, reutilization areas and surface drainages are especially important. Both the habitat coverage and the land use may be displayed on the same map if the degree of detail is not confusing.

PRELIMINARY ENDANGERMENT ASSESSMENT GUIDANCE MANUAL

ERRATA SHEET

- Page 2-18, Section 2.5.1.3, #1) Polycyclic Aromatic Hydrocarbons (PAHs). The manual currently requires that all potentially carcinogenic PAHs be assumed equivalent in cancer potency to benzo(a)pyrene on a weight basis until specified otherwise by the Cal/EPA. As potency equivalency factors exist, the PEA Guidance Manual is being modified to require calculation of benzo(a)pyrene equivalents utilizing the equivalency factors outlined below. The potential risk associated with each media of concern would then be calculated using the total benzo(a)pyrene equivalents.

Chemical Name	Slope Factor		Equivalency Factor
	Oral	Inhalation	
Benzo(a)anthracene			1/10
Benzo(b)fluoranthene			1/10
Benzo(j)fluoranthene			1/10
Benzo(k)fluoranthene			1/10
Benzo(a)pyrene	12	3.9	1.0
Chrysene			1/100
Dibenz(a,h)acridine			1/10
Dibenz(a,j)acridine			1/10
Dibenz(a,h)anthracene	4.1	4.1	
7H-dibenzo(c,g)carbazole			1.0
dibenzo(a,e)pyrene			1.0
Dibenzo(a,h)pyrene			10
Dibenzo(a,i)pyrene			10
Dibenzo(a,l)pyrene			10
7,12-dimethylbenz(a)anthracene	250	250	
Indeno(1,2,3-c,d)pyrene			1/10
3-methylcholanthrene	22	22	
5-methylchrysene			1/10

2. Page 2-19, Item #8, Inorganic Lead. The reference to 130 ppm is deleted. The lead screening value should be calculated using the current Leadsread model.

The leadsread model which generates lead screening values contains an intake value for the normal dietary contribution. The homegrown produce option supplements this. This normal dietary contribution was published by the U.S. Food and Drug Administration from their five-year “market basket” survey. The FDA recently published an update, from food analyzed in the five year period from 1986 through 1991. It contains the news that the lead level in the food supply has dropped. Therefore, the default in the leadsread model will be changed, with a resulting effect on the non-site-specific default screening value of 130 ppm.

3. Page 2-27, Figure 2-5 and Appendix B, Soil Saturation Concentrations. U.S. EPA has changed their methodology for calculating soil saturation concentrations. The revised soil saturation concentration equation takes into account the contaminant that is in the vapor phase in the pore spaces of the soil in addition to the amount dissolved in the soil’s pore water and sorbed to soil particles.

$$\begin{aligned} (C_{\text{sat}}) &= (S/p_b)(K_d p_b + \text{water-filled porosity} + (H')(\text{air-filled porosity})) \\ &= \frac{S \times (1.5K_d + 0.15 + H_c \times 41 \times 0.28)}{1.5} \end{aligned}$$

The volatilization factor-based inhalation soil screening levels are applicable only if the soil concentration is at or below C_{sat} . Therefore, the soil saturation concentration is the default screening value if the risk-based value exceeds the soil saturation concentration. The current methodology is contained in the “Soil Screening Guidance: Technical Background Document, May 1996, EPA/540/R-95/128.”

4. Page 2-31, Section 2.6. The California Environmental Protection Agency Department of Toxic Substances Control’s “Guidance for Ecological Risk Assessment at Hazardous Waste Sites and Permitted Facilities” dated July 4, 1996 is provided as a reference to clarify any outstanding issues if the application of the Preliminary Endangerment Assessment ecological risk component is at question.

CHAPTER THREE

PREPARATION OF THE PEA REPORT

This chapter provides guidance on how to organize the PEA report and what information should be included in the report. The purpose of the report is to document the results of the PEA investigation and screening evaluations and to recommend a course of action for the site.

3.1 DOCUMENTATION GUIDELINES

The following guidelines are presented to facilitate both the preparation of the PEA report and the Department's review and approval process.

- All data provided in the report should be presented as clearly and concisely as possible. The use of lists, bulleted outlines, tables, and figures are preferred over long narrative discussions.
- Avoid the use of large blocks of text unbroken by headings, graphics, tables or other visual organizers.
- References, photographs, laboratory analytical reports, and any other items which are used to substantiate statements in the PEA report should be attached as appendices.

3.2 SUGGESTED REPORT FORMAT

To provide consistency in documentation of PEA investigations, the Department recommends use of the report format provided in Figure 3.1.

3.3 REQUIRED REPORT CONTENTS

The specific information that must be included in the PEA report is discussed in the following section. Refer to these pages for guidance when preparing the report. If any information required cannot be obtained, a statement to that effect must be included in the report. If required information is omitted because it seems irrelevant to the site, the rationale for this omission must be included in the report. Omission of required information and rationale for omission are subject to approval by Department staff.

3.3.1 EXECUTIVE SUMMARY

The executive summary is the most complete summary of the site. This section should inform the reader of all the major aspects of the site. Specifically, this section should include, but not be limited to, very brief descriptions of the following:

- purpose of investigation;
- site background and current status;
- known and potential releases;
- significant contamination;
- pathways demonstrating potential threat;
- potentially exposed populations; and conclusions and recommendations.

3.3.2 INTRODUCTION

This section should briefly introduce the site and the organization of the report. In doing so, the preparer should provide the reason for performing the PEA

FIGURE 3.1: SUGGESTED REPORT FORMAT

i. Table of Contents	B. Presentation of Data
ii. List of Figures	C. Discussion of Results
iii. List of Tables	VII. Human Health Screening Evaluation
iv. List of Appendices	A. Exposure Pathways and Media of Concern
Executive Summary	B. Exposure Point Concentrations and Chemical Groups
I. Introduction	C. Toxicity Values and Summary Tables
A. Purpose and Scope of Work	D. Risk Characterization and Summary Tables
II. Site Description	E. Uncertainty Analysis
A. Site Identification Information	VIII. Ecological Screening Evaluation
B. Site Maps	A. Site Characterization
1. General Location Map	B. Biological Characterization
2. Detailed Site Diagram	C. Pathway Assessment
III. Background	D. Qualitative Summary
A. Site Status/Historical Site Information	IX. Community Profile
B. Hazardous Substance/Waste Management Information	X. Conclusions and Recommendations
IV. Apparent Problem	A. Summary and Conclusions
V. Environmental Setting	B. Recommendations for Further Action
A. Factors Related to Soil Pathways	C. Preliminary Scoping Recommendations
B. Factors Related to Water Pathways	XI. References
1. Ground Water Pathway	XII. Supporting Documentation (Appendices)
2. Surface Water Pathway	
C. Factors Related to Air Pathways	
VI. Sampling Activities and Results	
A. Summary of Activities	

investigation; the types and years of site operations; and the guidance documents followed during the investigation.

3.3.3 SITE DESCRIPTION

The site description should include information that identifies the physical setting of the site in relation to the surrounding area.

3.3.3.1 SITE IDENTIFICATION

The following information must be included in this section of the PEA report.

- 1) **Site Name:** Name of current business operation and/or land use at the site.
- 2) **Contact Person(s):** Name of the main contact person(s) for the above cited operation.
- 3) **Site Address:** Street address or nearest cross streets, city, state, county and zip code.
- 4) **Mailing Address:** Mailing address for the site if different from the street address (e.g., P.O. Box or off-site business).
- 5) **Phone Number:** Phone number of any on-site or off-site business office.
- 6) **Other Site Names:** Former or alternate names for the current and historical operations on-site.
- 7) **USEPA Identification Number:** If assigned.
- 8) **CalSites Database Number:** If assigned.

- 9) **Assessor's Parcel Number and Maps:** Parcel number(s) for the site and copy of the County Assessor's plat map for the parcel(s) where the site is located.

- 10) **Township, Range, Section, and Meridian:** Corresponding to the site location.

- 11) **Land Use and Zoning:** Current land use and zoning and any proposed land use or zoning changes. Land use categories may include, but are not limited to: commercial; industrial; institutional; single family residential; multi-family residential; cultivated land; pasture or range land; wood or forest land; meadow; open grass areas (e.g., parks, golf courses, cemeteries, etc.); paved lots (e.g., parking lots, storage areas, etc.); public easements/right-of-ways (e.g., roads, utilities, pipelines, water canals, etc.); or landfills.

3.3.3.2 SITE MAPS

At a minimum, a site location map and a site specific map (facility diagram) should be prepared. The site location map should show the general location of the site relative to its surrounding area (scale 1:2400). The site location map should identify major highways, surface waters, land use, sensitive populations and critical habitats. The site specific map should include all significant site features (buildings, tanks, ponds, sumps etc.), both current and historical, and should be drawn to a scale appropriate for the site size. All maps should be oriented with north at the top of the page.

3.3.4 BACKGROUND

3.3.4.1 SITE STATUS AND HISTORY

Each data element below should be provided for all current and past business operations at the site.

- 1) **Business Type:** Identity and description of the types of businesses which are currently operating or have operated at the site in the past.
- 2) **Years of Operation:** Operating dates for each business identified.
- 3) **Prior Land Use:** Identity of the land use prior to development of the site (including the placement of fill upon the property).
- 4) **Facility Ownership/Operators:** Identity of all persons or corporations which owned and/or operated businesses on the site. Description of the organizational structure of the businesses (corporation, limited partnership, etc.). Names of operators, partners, and/or any person(s) having operational control of the facility. Description of the roles these persons/corporate officers played in the day-to-day operations at the site. Current street addresses, mailing addresses, and phone numbers for each person and/or corporation identified.
- 5) **Property Owners:** Narrative summary of the property ownership at the site extending back to the date of first business operations. The narrative should reference title documents and tax assessor parcel maps which should be included as appendices. The narrative should also include current street addresses, mailing addresses, and phone numbers for all persons/corporations identified.

- 6) **Surrounding Land Use:** History and/or general uses of properties in the area surrounding the site should be researched to the extent to which the information is useful to determine the influence of surrounding property use(s) on the site.

3.3.4.2 HAZARDOUS SUBSTANCE/ WASTE MANAGEMENT INFORMATION

The following information regarding hazardous substance/waste management activities for all current and former businesses that have operated on-site should be provided in the PEA report.

- 1) **Business/Manufacturing Activities:** Concise description of activities or manufacturing processes for each business currently and formerly operating on-site which utilized or generated hazardous substances/wastes. Summary descriptions, diagrams, flow charts, and/or tables are preferable to long narrative descriptions. At a minimum the following information should be provided.
 - a) Type and approximate quantities of products produced/sold per year or the number of services rendered per year.
 - b) Amount/type of hazardous substances and/or wastes generated per year.
 - c) Primary materials and chemicals used, handled, or sold on-site.
 - d) Descriptive overview of the major physical/chemical processes used (e.g. mixing, distillation, combustion, oxidation, polymerization, etc.) for each process or activity.

- 2) **On-Site Storage, Treatment, and Disposal:** Provide a concise description of hazardous waste/substance storage, treatment, and disposal practices for each business currently and formerly operating on-site. Summary descriptions, diagrams, flow charts, and/or tables are preferable to long narrative descriptions. At a minimum the following information should be provided.

- a) Type, capacity, contents, and location of hazardous substance/waste storage units on-site (e.g. tanks, drum storage areas, sumps, pits, ponds, etc.).
- b) Type, capacity, and location of hazardous waste treatment facilities on-site (e.g. neutralization, filtration, distillation, incineration, etc.).
- c) Hazardous waste disposal practices on-site (e.g. land disposal, land spreading, injection, etc.). Include volume of waste disposal over time.
- d) Hazardous substance and/or waste containment measures specific to each treatment, storage, and disposal unit on-site.
- e) Waste recovery and/or recycling practices utilized on-site. Indicate volumes and types of wastes recovered/recycled annually.
- f) Origin, types, and quantities of any hazardous substances/wastes from off-site sources treated, disposed, or stored on the site.
- g) Identification of all leaks, spills, releases or threats of releases of any hazardous substances at or

from the site (into the environment or within on-site structures). Include when, how, and where such releases occurred and the volume and types of materials released.

- 3) **Regulatory Status:** Provide the status of any federal, state, or local hazardous substance/waste permits currently or previously held by the facility. Include effective dates of the permit(s) and specific permit requirements and conditions. Attach copies of the permits in the appendices of the PEA report.

- 4) **Inspection Results:** Summarize significant findings of federal, state, or local inspections of current or past operations on-site. Include significant sampling results, scope and purpose of the inspection, and conclusions drawn by the inspector.

- 5) **Prior Assessments/Remediation:** Identify, evaluate and summarize results of all assessments, sampling efforts and cleanup activities which have taken place at the site prior to the PEA.

3.3.5 APPARENT PROBLEM

This section should summarize the available information regarding known or potential sources of contamination which constitute the primary reason for investigating the site. The summary should include documentation of spills or releases (date, location, material, quantities), identification of the contaminants of concern, identification of the primary human and environmental resources of concern, and a description of the exposure pathways. Detailed information related to the apparent

problem should be described in subsequent sections of the report.

3.3.6 ENVIRONMENTAL SETTING

During the Background Research for the PEA, information should have been collected regarding the site's environmental characteristics. This information identifies the site environmental conditions which would influence the transport of contaminants from the source of contamination through identified potential exposure pathways to the exposed individual or environmental receptor. The Department will use the information provided to prioritize those sites which require remediation.

3.3.6.1 FACTORS RELATED TO SOIL PATHWAYS

- 1) Describe the topography of the site and the surrounding areas.
- 2) Describe any evidence of environmental impacts from a release at the site (e.g., stained soil, stressed vegetation, dead or ill wildlife, etc).
- 3) Describe the predominant soil groups for the site. Use site specific geologic logs when available. Identify the least and most permeable continuous layers of soil and the permeability of each layer.
- 4) Describe the surface slope at the site. Also, provide the slope of any intervening terrain between the site and the nearest downhill surface-water body. If the site is in a closed basin or actually located in surface water, this fact should be stated.
- 5) Describe accessibility to the site in terms of both natural and man-made features or structures which currently restrict human access to the site.

- 6) Describe any measures which have been taken to contain or prevent direct contact with hazardous substances in or on the soil at the site.
- 7) Provide the distance to and location of the nearest potentially affected residential area, school, business, day care center, nursing home, senior citizen community, and hospital (for facilities within one mile of the site).

3.3.6.2 FACTORS RELATED TO WATER PATHWAYS

If a release or threatened release of hazardous substances to water exists at the site, then the following information must be provided.

- 1) Describe the hydrogeology beneath the site in terms of known aquifers, depth to aquifers, hydraulic conductivities, confining layers, discontinuities, aquifer interconnections, and any other features of significance.
- 2) Identify the aquifers which have been contaminated by a release from the site, or which are threatened to be contaminated as a result of migration of hazardous substances from a release at the site. Identify any aquifers which are interconnected with an aquifer that has been contaminated by a release from the site.

Data source: Sampling data; Local water districts utilities; County health departments; Department of Health Services, Public Water Supply Branch; DWR; RWQCB.

- 3) For each of the aquifers identified above, provide the following

information for wells within a three-mile radius of the site:

- a) The use(s) of ground water from wells which draws from the aquifer(s) (e.g., drinking water, irrigation, industrial process water, etc.).
- b) The distances to the nearest well and nearest drinking water well which draw from the aquifers(s).
- c) The direction and velocity of flow within the aquifer(s).
- d) The approximate number of service connections and population served by drinking water wells from the aquifer(s).

Data source: Local water districts and utilities; County planning and health departments; Local irrigation districts; Department of Health Services, Public Water Supply Branch; DWR; USGS; RWQCB.

- 4) Describe the possible migration route(s) from the areas of hazardous substance contamination and/or storage to nearby surface waters, marshlands, wetlands, or wildlife habitats in the event of surface water runoff or flooding.

Data source: Personal observation; aerial photographs; USGS Maps.

- 5) Describe the locations and uses of surface waters, marshlands, wetlands, and wildlife habitats which may be potentially affected by migration of contaminants from the site. Also, provide the location and distance to the nearest surface water, marshland, wetland, and wildlife habitat which may be

affected by migration of the contaminants.

Data source: USGS Maps; other maps; Department of Fish and Game; local planning department; U.S. Bureau of Reclamation; SWRCB.

- 6) Describe any past or existing measures for preventing or mitigating surface water runoff from the site (e.g., berms, diversion systems, diking, sealed containers for hazardous substances, runoff collection systems, etc.).

Data source: Facility records; Department files; RWQCB files.

- 7) Identify the approximate population served (number of people drinking water) by each surface water intake within three (stream) miles downstream of the probable point of entry of runoff from a site to a stream/river and one mile from the probable point of entry to a static body of water. Also identify the approximate number of acres of food/forage cropland irrigated by water from each intake and the approximate number of livestock or poultry which consume water from each intake.

Data source: U.S. Census Bureau; Local/regional planning health departments; Department of Health Services, Public Water Supply Branch; Local irrigation districts; DWR.

- 8) Provide the approximate slope (in percentage) of the site and the intervening terrain between the site and any surface water which may potentially accept runoff.

3.3.6.3 FACTORS RELATED TO AIR PATHWAYS

Information for this section needs to be provided only if sampling data exists to document a release of a hazardous substance to the atmosphere or if the threat of a release exists. The threat of a release exists if hazardous substances (including contaminated soils) on the site are subject to wind dispersal, evaporation, dispersal from fire/explosion, or if dispersal of the hazardous substances has been observed visually. If a release has been documented or a threatened release exists at the site, provide the following information.

- 1) Describe the known or potential sources(s) and mechanism for the release or threatened release.

Data source: Site records; local air quality district.

- 2) Provide the daily prevailing wind direction and daily average velocity for the site.

Data source: Local air district; local weather stations.

- 3) Describe local climatic factors (e.g., seasonal temperatures, seasonal precipitation, seasonal temperature inversions, seasonal wind patterns, and seasonal extreme events).

Data source: Local air quality districts; local weather stations.

- 4) Describe the timing of the release or threatened release (e.g., intermittent release related to facility operation, continuous release from an impoundment, potential release if heavy machines disturb soils, etc.).

Data source: Facility records; local air quality district.

- 5) Describe the possible dispersion route(s) for a release or threatened release (e.g., via a stack emission, evaporation, wind, fire/explosion, etc.).

Data source: Local air quality districts, facility records.

- 6) Provide the approximate population of residents and workers which may be affected by a release or threatened release of hazardous substances.

Data source: U.S. Census Bureau; local/regional planning databases.

- 7) Provide the location and distance from the site to any of the following areas which may be impacted by a release or threatened release of hazardous substances:

- commercial/industrial;
- national/state parks, forests, wildlife reserves, and residential areas;
- agricultural lands (in production within five years) for both prime and non-prime agricultural land; and
- historic/landmark sites.

Data source: Local planning departments; Department of Food and Agriculture; DWR; Department of Forestry; maps

- 8) If not previously indicated in other sections of the PEA report, provide the type, location, and distance from the release or threatened release of hazardous substances to the following sensitive environments:

- Schools
- day care centers
- hospitals
- nursing homes
- retirement communities
- any other sensitive populations

- coastal wetlands (within a two-mile radius);
- fresh-water wetlands (within a one-mile radius); and
- habitat for special species (within a one-mile radius).
- national parks

Data source: Local planning department, maps, NDDB, DWR, SWRCB, physical measurement.

3.3.7 SAMPLING ACTIVITIES AND RESULTS

In the three subsections that follow, the report should summarize the sampling activities performed, present the analysis data, and provide a discussion of the results.

3.3.7.1 SUMMARY OF ACTIVITIES

The sampling plan provided a framework for field activities and allowed flexibility for some decisions to be made in the field. This section should describe the activities that were performed, document decisions made in the field and identify any deviations from the sampling plan and their rationale. Also include information regarding the handling of analytical samples from the time of collection until final analysis.

3.3.7.2 PRESENTATION OF DATA

Use tables, charts, etc. to summarize the sample analysis results for each medium. At a minimum the information presented should include the chemical name, sample type, sample # or location, sample depth (if appropriate), detection limit, units, and date collected. Analysis results as reported from the lab, including QA/QC data should be provided in an appendix to the report.

3.3.7.3 DISCUSSION OF RESULTS

Provide a summary of the conclusions reached upon evaluation of the

analytical data. Identify unexpected or conflicting results, unusable data, and field and/or laboratory interferences and provide potential rationale. This section should also identify secondary analysis performed to confirm original results that may have been questionable.

3.3.8 HUMAN HEALTH SCREENING EVALUATION

The introduction to the Human Health Screening Evaluation is to contain a brief summary of the information presented in the remainder of the section. The summary should introduce the four components of the human health screening evaluation (3.3.8.1 - 3.3.8.4) and describe the primary purpose of each component as it applies to the site.

3.3.8.1 EXPOSURE PATHWAYS AND MEDIA OF CONCERN

Use a Conceptual Site Model to show potential exposure pathways (See Figure 2.1 for example). If there are several distinct areas of contamination, the use of a separate Conceptual Site Model for each area is acceptable for clarity. If the pathways of exposure are the same for each area, only one model is needed; however, a statement to that fact is required. Also include a detailed description of each significant pathway and state if the release is actual or threatened (also state if the release is continuous, intermittent, etc.). Provide a qualitative rationale if a particular exposure pathway is to be excluded from evaluation. The exposed population for each potential pathway is to be included with this section.

3.3.8.2 EXPOSURE CONCENTRATIONS AND CHEMICALS

In this section include tables identifying the chemicals of concern, their physical constants and the concentrations for each medium that were used as input

for the screening evaluation (this should be displayed for each separate area of contamination). Every table is to have a descriptive title name and the name of the potentially contaminated area it represents if applicable. If the site has historic sampling data, significant results should be included in separate, chronological tables with each table clearly noting the sampling date. If there are large volumes of data, include only the significant findings in this section and include all other data in an appendix. Provide the rationale if a particular chemical is to be excluded from evaluation. All background data should be included in this section, with any suspected anomalies noted. A table can be used to compare metals found on site with background levels.

3.3.8.3 TOXICITY VALUES

Each chemical of concern should have all relevant and significant human toxicity information described. This is to include a summary table with the cancer potency factor and reference dose for each chemical of concern, and each route of exposure. The table should reference the source and date of the toxicity values (e.g., Cal/EPA, IRIS, HEAST), and not the toxic endpoint or target organ of concern. Toxicity data for each route can be displayed in a table along with the risk associated for that pathway. This section should clearly indicate which toxicity values are based on cross route extrapolation.

3.3.8.4 RISK CHARACTERIZATION SUMMARY

The risk characterization summary should integrate the exposure assessment and chemical toxicity information. Significant findings and determinations are to be included in this section, such as the risk and hazard for each chemical and each exposure pathway. The summation of cancer risk and hazard over all chemicals and

exposure routes should also be included. Conclusions regarding the screening evaluation determinations are to be described in this section.

The risk and hazard estimated which result from application of this screening evaluation do not represent absolute estimates at a specific site, since generic assumptions for residential land use were used. The information provided for the PEA screening evaluation is often based on limited sampling information. The goal of the PEA screening evaluation is to insure that no potential health hazard is overlooked; therefore, the screening evaluation's assumptions and default values are restricted to a reasonable maximum exposure scenario. Providing a list of the assumptions used in the screening evaluation in this section of the report could provide the reader with useful insight into the conservative nature of the evaluations.

3.3.9 ECOLOGICAL SCREENING EVALUATION

The introduction to the Ecological Risk Assessment is to contain a summary of the information presented in this section of the PEA Report.

3.3.9.1 SITE CHARACTERIZATION

A description of the site and the general ecology proximal to the site is to be described, noting locations of any nearby wildlife habitats.

3.3.9.2 BIOLOGICAL CHARACTERIZATION

List and describe all wildlife habitats potentially affected by the site. The nature of the habitat should be detailed including cyclic changes. The rationale for excluding any nearby wildlife habitat from evaluation should be provided.

List all special species potentially impacted by the site. State if any of these species have been observed on the site. Note if a species is particularly sensitive to any chemicals of concern found on site.

3.3.9.3 PATHWAY ASSESSMENT

Describe the onsite contamination and the potential exposure pathways to the environment. Use a Conceptual Site Model to illustrate general potential exposure pathways, then a more detailed exposure pathway analysis table can be used for each habitat. Include a discussion on whether this exposure is onsite or offsite and describe the potentially affected species. Any past documented or observed impacts to wildlife habitats or special species from the site is to be described in this section. Also describe any interim remedial measures that may abate potential impacts to the environment from the chemicals of concern.

3.3.9.4 QUALITATIVE SUMMARY

Provide a qualitative description of the magnitude, duration, and frequency of exposure for the various biological receptors, representing multiple trophic levels, for each contaminant or area of contamination. Conclusions regarding current or potential environmental impacts are to be included. If the site contamination does not impact the environment, a qualitative statement to that effect and supporting rationale should be provided. In addition, statements should also be made that areas currently or potentially impacted by the site are not utilized by non-human receptors and/or do not contain wildlife habitats or endangered or threatened species (if that is the case).

3.3.10 COMMUNITY PROFILE

This section should be a summary of the community profile prepared as part of the PEA investigation. The summary should highlight the assessment of community concern and the public participation actions taken. Also include any recommendations for future public participation activities. If a community profile was not prepared during the PEA investigation, provide the rationale for its omission.

3.3.11 CONCLUSIONS AND RECOMMENDATIONS

3.3.11.1 SUMMARY AND CONCLUSIONS

The conclusions of the PEA report need to address three main questions:

- Have current or past practices of handling hazardous waste/substances resulted in a release or threat of release at the site;
- If a release has occurred or a threatened release exists, does it pose a significant threat to public health or the environment; and
- Does the release pose an immediate potential hazard to public health or the environment which would require the implementation of an expedited response action.

In answering the above questions, the conclusions should be specific, concise, and supported by information presented in the body of the report. All conclusions presented in this section must be consistent with the data and analysis presented elsewhere in the PEA report.

If a release or threatened release does not exist, this section should include a statement to that effect and reference

the information contained in the body of the report which supports the statement.

3.3.11.2 RECOMMENDATIONS

Based on the conclusions presented in the previous section, the preparer will make a recommendation(s) regarding the need for further action at the site. In its simplest form the recommendation will either be "no further action" or "additional action required".

A "no further action" recommendation can be made in cases when no release of hazardous substances has occurred and in cases when levels of contamination are determined to be insignificant. Any recommendations for "no further action" at sites where a release has been documented must be supported by information provided in the human health and environmental threat evaluation portion of the report.

At sites with significant contamination, a recommendation for further action to investigate or remediate the site must be made. This recommendation should not simply state that "further action is required". The recommendation should identify additional investigation and/or remediation needs and strategies to address them.

In addition to the recommendations above for long term actions, this section must include recommendations for expedited response actions necessary to mitigate any immediate potential hazards to public health or the environment. These actions can take a number of forms, including but not limited to: removing highly contaminated soils to prevent further migration; placing a polymer coating onto soils to prevent dispersion and runoff; placing a fence and warning signs around contaminated areas to prevent direct contact; and/or providing alternative drinking water sources to residents near sites where drinking water supplies are

contaminated. When determining if expedited response actions are required, consider the following:

- Does the site have unrestricted access?
- Are there hazardous substances in surface impoundments, unsealed or improper containers, piles, leaking tanks, or other unapproved storage?
- Have the substances been spilled on the ground or other surfaces accessible to humans or animals?
- Does the toxicity of the hazardous substances at the site pose an immediate public health or environmental endangerment?
- What is the most immediate exposure threat facing nearby populations?
- How many people live or work around the site and what is the distance of that population from the site?
- Is there a confirmed instance in which exposure to hazardous substances at a site has caused injury, illness, or death to humans, domestic or wild animals, or plants?
- Can it reasonably be inferred from the geology and hydrology of the site and surrounding area and the nature of the contaminants that there is the potential for off-site migration?
- Is there evidence of off-site migration?
- Are there active wells in the suspected pathway of migration?
- Is there a potential for the contaminant to become airborne?

- Can a reasonable inference be made that taking an immediate action could significantly reduce continued or potential hazardous substance migration from the site through air emissions, surface water runoff, groundwater migration, or subsurface gas migration?

3.3.11.3 PRELIMINARY SCOPING RECOMMENDATIONS

For sites that will continue in the Site Mitigation Process, the next step after completing the PEA is the RI/FS. The RI is conducted to characterize the full extent of contamination at the site and to obtain information needed to identify, evaluate, and select cleanup alternatives. The FS includes an analysis of remediation alternatives based on the nine National Contingency Plan (NCP: USEPA 1988a) evaluation criteria.

The first step of the RI/FS is the planning or scoping of the project to focus activities and streamline the process, thereby preventing needless expenditures and loss of time in unnecessary sampling and analysis. Ideally, all sites would begin the RI/FS immediately upon completion of the PEA. Unfortunately, due to limited resources, most sites experience a lag time between the PEA and initiation of the RI/FS. In order to take full advantage of the interim and maintain the momentum of the investigation, this section will include steps to scope the RI/FS upon completion of the PEA. These steps will serve to identify potential data gaps, keep information on site conditions current, and help establish priorities for future remedial actions. Upon approval of the PEA report, the parties responsible for the

site should initiate the implementation of the scoping activities identified in the report.

Specific activities that may be conducted during project scoping include:

- Evaluating the PEA data to update the conceptual site model and identify data gaps.
- Initiating limited field investigations if available data are inadequate to develop an updated conceptual site model and adequately scope the project. An example of limited field investigation would be installation of monitoring wells and/or collecting samples from existing wells on a quarterly basis to monitor for the chemicals of concern or hydrological studies.
- Identifying preliminary remedial action objectives and likely response actions for the specific projects. This may include identifying the need and the schedule for treatability studies to better evaluate potential remedial alternatives.
- Conducting treatability studies identified in scoping.

Full project scoping activities can be found in the USEPA's Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. Potential scoping needs applicable to baseline risk assessment data collection can be found in USEPA's Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A).

GLOSSARY

ANNUAL WORKPLAN. A key element in the Department's management and planning process. This planning document allocates resources to the highest priority work to be accomplished.

COMMUNITY ASSESSMENT. A series of interviews with local community members which will aid the Department in characterizing and determining the informational needs and desires of the community. (DTSC)

COMMUNITY PROFILE. A written presentation of information gathered through the community assessment regarding community concerns that form the basis for determining public notification and public participation needs.

CONCEPTUAL SITE MODEL. A "model" of a site developed at scoping using readily available information. Used to identify all potential or suspected sources of contamination, types and concentrations of contaminants detected at the site, potentially contaminated media, and potential exposure pathways, including receptors. This model is also known as "conceptual evaluation model". (USEPA, 1991b)

CONTINUOUS CORE. A continuously retrieved cylindrical or columnar piece of solid rock or section of soil, usually 5-10 cm in diameter, taken as a sample of an underground formation by a special hollow-type drill bit, and brought to the surface for geologic examination and/or chemical analysis. It records the entire section of the rock or soil penetrated. (Definition adapted from "Glossary of Geology", American Geological Institute, 1977)

EXPEDITED RESPONSE ACTION. A removal action which occurs during or soon after the site evaluation phase. These removals generally consist of removing leaking drums/tanks, fencing the site, and placing caps of protective covering over known areas of contamination.

EXPOSURE POINT. A location of potential contact between an organism and a chemical or physical agent. (USEPA, 1991b)

EXPOSURE ROUTE. The way a chemical or physical agent comes in contact with an organism (i.e., by ingestion, inhalation, dermal contact). (USEPA, 1991b)

FIELD DUPLICATES. Independent samples which are collected as close as possible to the same point in space and time. They are two separate samples taken from the same source, stored in separate containers, and analyzed independently. These duplicates are useful in documenting the precision of the sampling process. (USEPA, 1986)

HAZARD INDEX (HI). The sum of two or more hazard quotients for multiple substances and/or multiple exposure pathways. (USEPA, 1991b)

HAZARD QUOTIENT (HQ). The ratio of a single substance exposure level over a specified time period to a reference dose for that substance derived from a similar exposure period. (USEPA, 1991b)

PRELIMINARY REMEDIATION GOALS (PRGs). Initial clean-up goals that (1) are protective of human health and the environment and (2) comply with Applicable or Relevant and Appropriate Requirements. They are developed early in the process based on readily available information and are modified to reflect results of the baseline risk assessment. They also are used during analysis of remedial alternatives in the remedial investigation/feasibility study. (USEPA, 1991b)

QUANTITATION LIMIT. The lowest level at which a chemical can be accurately and reproducibly quantitated. Usually equal to the instrument detection limit multiplied by a factor of three to five, but varies for different chemicals and different samples. (USEPA, 1991b)

REFERENCE CONCENTRATION(RfC). An estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious noncancer effects during a lifetime. Expressed as a concentration of contaminant in air (mg/m³). (Adapted from IRIS database, July 1, 1990)

REFERENCE DOSE (RfD). An estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious noncancer effects during a lifetime. Expressed in mg/kg of body weight per day. (Adapted from IRIS database, July 1, 1990)

REMEDIAL ACTION. (a) Those actions which are consistent with a permanent remedy, that are taken instead of, or in addition to, removal actions in the event of a release or threatened release of a hazardous substance into the environment... (DTSC, 1991)

(b) Those actions which are necessary to monitor, assess, and evaluate a release or a threatened release of a hazardous substance. (DTSC 1991)

REMOVAL (ACTION). Includes the cleanup or removal of released hazardous substances from the environment or the taking of other actions as may be necessary to prevent, minimize, or mitigate damage which may otherwise result from a release or threatened release.... (DTSC 1991)

RISK-BASED PRGs. Concentrations levels set at scoping for individual chemicals that correspond to a specific cancer risk level of 10⁻⁶ or an HQ/HI of 1. They are generally selected when ARARs are not available. (USEPA, 1991b)

SLOPE FACTOR (SF). A plausible upper-bound estimate of the probability of a response per unit intake of a chemical over a lifetime. The slope factor is used to estimate an upper-bound probability of an individual's developing cancer as a result of a lifetime of exposure at a particular level of a potential carcinogen. (USEPA, 1991b)

SPLIT SAMPLES. Aliquots of sample taken from the same container and analyzed independently. These are usually taken after mixing or compositing and are used to document intra- or interlaboratory precision. (USEPA, 1986)

VADOSE ZONE. The zone between the land surface and the water table. (DTSC, 1991)

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APPENDIX A

TABLE 1: PREDICTED Kp ESTIMATES FOR COMMON POLLUTANTS

Chemical	CAS No.	MWT	log Kow	(cm/hr)
Acetaldehyde	75070	44.1	-0.22	7.2e-04
Acetamide	60355	59.0	-1.26	1.1e-04
Acetylaminofluorene, 2-	53963	223.0	3.24	1.7e-02
Acrolein	107028	56.1	-0.10	7.4e-04
Acrylamide	79061	71.0	-0.67	2.4e-04
Acrylonitrile	107131	53.1	0.25	0.0014
Aldrin	309002	365.0	3.01	1.6e-03
Allyl chloride	107051	76.5	1.45	7.0e-03
1-Amino-2 methylantraquinone	82280	237.3	2.80	6.6e-03
Aminoanthraquinone, 2-	117793	223.0	2.15	2.8e-03
Aminoazobenzene, p-	60093	197.0	2.62	8.7e-03
Aminoazotoluene, o-	97563	225.3	3.92	4.9e-02
Aminobiphenyl, 4-	92671	169.2	2.80	1.7e-02
Aniline	62533	93.1	0.90	2.2e-03
Anisidine, o-	90040	145.0	1.18	1.7e-03
Auramine	492808	267.4	3.54	1.5e-02
Benzo-b-fluroanthene	205992	252.3	6.12	1.2e+00
Benzene	71432	78.1	2.13	2.1e-02
Benzidine	92875	184.2	1.34	1.3e-03
Benzo-a-anthracene	56553	228.3	5.66	8.1e-01
Benzo-a-pyrene	50328	250.0	6.10	1.2e+00
Benzoic acid	65850	122.0	1.87	7.3e-03
Benzotrichloride	98077	195.0	2.92	1.5e-02
Benzyl chloride	100447	127.0	2.30	1.4e-02
Bis(2-chlorethyl)ether	111444	143.0	1.29	2.1e-03
Bromodichloromethane	75274	163.8	2.09	5.8e-03
Bromoform	75252	252.8	2.37	2.6e-03
Bromomethane	74839	95.0	1.19	3.5e-03
Bromophenol, p-	106412	173.0	2.65	1.3e-02
Butadiene, 1,3-	106990	54.0	1.99	2.3e-02
Butanediol, 2,3-	513859	90.1	-0.92	1.2e-04
Butanol, n-	71363	74.1	0.65	1.9e-03
Butoxyethanol, 2-	111762	118.0	0.83	1.4e-03
Captan	133062	300.0	2.35	1.3e-03
Carbon disulfide	75150	80.0	2.24	2.4e-02
Carbon tetrachloride	56235	153.8	2.83	2.2e-02
Chlordane	57749	409.8	5.54	5.2e-02
Chlordane (cis)	5103719	410.0	5.47	0.046
Chlordane (trans)	5103742	410.0	5.47	0.046
Chlorobenzene	108907	112.6	2.84	4.1e-02

SOURCE: U.S. Environmental Protection Agency. January 1992. Interim Report Dermal Exposure Assessment: Principles and Applications. EPA/600/8-9 011

TABLE 1: (Continued)

Chemical	CAS No.	MWT	log Kow	Kp (cm/hr)
Chlorocresol	59507	142.6	3.10	4.1e-02
Chlorodibromomethane	124481	208.3	2.23	3.9e-03
Chloroethane	75003	64.5	1.43	8.0e-03
Chloroform	67663	119.4	1.97	8.9e-03
Chloromethane	74873	50.5	0.91	0.0042
Chloromethyl methyl ether	107302	80.5	0.00	6.2e-04
Chlorophenol, o-	95578	128.6	2.16	1.1e-02
Chlorophenol, p-	106489	128.6	2.39	1.6e-02
Chlorothalonil	1897456	265.9	3.86	2.5e-02
Chloroxylenol	-	135.2	-	-
Chrysene	218019	228.3	5.66	8.1e-01
Cresidine, p-	120718	137.2	1.67	4.3e-03
Cresol, m-	108394	108.1	1.96	1.0e-02
Cresol, o-	95487	108.1	1.95	1.0e-02
Cresol, p-	106445	108.1	1.94	1.0e-02
D&C Red No. 19	81889	479.0	0.00	2.3e-06
DDD	72548	320.0	5.80	2.8e-01
DDE	72559	318.0	5.69	2.4e-01
DDT	50293	355.0	6.36	4.3e-01
Decanol	112301	158.3	4.11	1.7e-01
Di-2-ethylhexyl phthalate	117817	391.0	5.11	3.3e-02
Diaminoanisole, 2,4-	615054	138.2	-0.12	2.3e-04
Diaminotoluene	95807	122.0	0.34	6.0e-04
Diaminotoluene, 2,4-	101804	200.0	2.06	3.3e-03
Dibenzo (a,h)anthracene	226368	278.4	6.84	2.7e+00
Dibutyl phthalate	84742	278.0	4.13	3.3e-02
Dichlorobenzene, 1,2-	95501	147.0	3.38	6.1e-02
Dichlorobenzene, 1,3-	541731	147.0	3.60	8.7e-02
Dichlorobenzene, 1,4-	106467	147.0	3.39	6.2e-02
Dichlorobenzidine, 3,3'	91941	253.1	3.51	1.7e-02
Dichlorodifluoromethane	75718	120.9	2.16	1.2e-02
Dichloroethane, 1,1-	75343	99.0	1.79	8.9e-03
Dichloroethane, 1,2-	107062	99.0	1.48	5.3e-03
Dichloroethylene, 1,1-	75354	96.9	2.13	1.6e-02
Dichloroethylene, 1,2-	156592	96.9	1.86	1.0e-02
Dichlorophenol, 2,4-	102832	163.0	2.92	2.3e-02
Dichloropropane, 1,2-	78875	113.0	2.00	0.01
Dichloropropene, 1,3-	542756	111.0	1.60	0.0055
Dichlorvos	62737	221.0	1.47	9.5e-04
Dieldrin	60571	381.0	4.56	1.6e-02
Diepoxybutane	1464535	86.1	-1.84	2.8e-05
Diethyl phthalate	84662	222.0	2.47	4.8e-03
Diethyl sulfate	64675	154.0	1.14	1.4e-03

TABLE 1: (Continued)

Chemical	CAS No.	MWT	log Kow	Kp (cm/hr)
Dimethoxybenzidine, 3,3'-	119904	254.4	1.81	0.001
Dimethyl phthalate	131113	194.0	1.56	1.6e-03
Dimethyl sulfate	77781	126.0	1.16	2.2e-03
Dimethylamine, n-nitroso-	62759	74.1	-0.57	2.7e-04
Dimethylaminoazobenzene, 4-	60117	225.0	4.58	1.4e-01
Dimethylbenzidine, 3,3'-	119937	212.3	2.34	4.4e-03
Dimethylcarbamyl chloride	79447	107.5	0.00	4.2e-04
Dimethylhylhydrazine, 1,1-	57147	60.0	-1.50	7.1e-05
Dimethylphenol, 2,4-	105679	122.2	2.30	1.5e-02
Dimethylphenol, 3,4-	95658	122.2	2.23	1.3e-02
Dinitrotoluene, 2,4-	121142	182.1	1.98	3.8e-03
Dinitrophenol, 2,4-	51285	184.1	1.54	0.0018
Dinitrotoluene, 2,6-	606202	182.1	1.72	0.0025
Dioxane, 1,4-	123911	88.1	-0.27	3.6e-04
Diphenylamine, n-nitroso-	86306	198.2	3.50	3.6e-02
Diphenylhydrazine, 1,2-	122667	184.2	2.94	1.8e-02
Dipropylamine, n-nitroso-	621647	130.2	1.36	2.8e-03
Endrin	72208	381.0	4.56	1.6e-02
Epichlorohydrin	106898	92.0	-0.21	3.7e-04
Ethanol	64175	46.0	-0.31	6.0e-04
Ethanol, 2-(2-butoxyethoxy)-	112345	162.0	-0.92	4.4e-05
Ethanol, 2-(2-ethoxyethoxy)-	111900	134.0	-0.08	2.5e-04
Ethanol, 2-(2-methoxyethoxy)-	111773	120.0	-0.42	1.8e-04
Ethoxyethanol, 2-	110805	90.0	-0.10	4.6e-04
Ethoxyethyl acetate, 2-	111159	132.0	0.65	8.6e-04
Ethyl acrylate	140885	100.0	1.32	4.0e-03
Ethyl carbamate	51796	89.0	-0.15	4.3e-04
Ethyl ether	60297	74.1	0.89	2.9e-03
Ethylbenzene	100414	106.2	3.15	7.4e-02
Ethylene oxide	75218	44.1	-0.30	6.3e-04
Ethylenedibromide	106934	188.0	1.96	3.3e-03
Ethyleneimine	151564	43.0	-1.12	1.7e-04
Ethylenethiourea	96457	96.0	-0.66	1.7e-04
Ethylphenol, p-	123079	120.0	2.26	1.4e-02
Fluoranthene	206440	202.3	4.95	3.6e-01
Formaldehyde	50000	30.0	0.35	2.2e-03
Glycerol	56815	92.1	-1.76	2.9e-05
Heptachlor	76448	373.5	4.27	1.1e-02
Heptanol	111706	116.0	2.41	1.9e-02
Hexachlorobenzene	118741	284.8	5.31	0.21
Hexachlorobutadiene	87683	260.8	4.78	1.2e-01
Hexachloroethane	67721	236.7	3.93	4.2e-02
Hexamethylphosphoramide	680319	179.0	0.03	1.6e-04

TABLE 1: (Continued)

Chemical	CAS No.	MWT	log Kow	Kp (cm/hr)
Hexanol	111273	102.0	2.03	1.3e-02
Hydrazine/Hydrazine sulfate	302012	32.0	-2.07	4.1e-05
Indeno(1,2,3-CD)pyrene	193395	276.3	6.58	1.9e+00
Isophorone	78591	138.2	1.70	4.4e-03
Lindane	58899	291.0	3.72	1.4e-02
Maneb	12427382	265.3	0.00	4.6e-05
Mechlorethamine	51752	156.0	1.07	1.2e-03
Methanol	67561	32.0	-0.77	0.00035
Methoxyethanol, 2-	109864	76.0	-0.77	0.00019
Methoxypropan-2-ol, 1-	107982	90.0	-0.18	0.0004
Methyl ethyl ketone	78933	72.0	0.29	1.1e-03
Methyl hydroxybenzoate	99763	152.1	1.92	0.0052
Methyl iodide	74884	142.0	1.51	3.1e-03
Methylaziridine, 2-	75558	57.0	-0.60	3.2e-04
Methylene bis(2-chloroaniline), 4,4'-	101144	267.2	3.94	2.8e-02
Methylene bis(N,N'-dimethyl)aniline, 4,4'-	101611	254.0	4.75	1.3-01
Methylene chloride	75092	84.9	1.25	4.5e-03
Methylenedianiline, 4,4'-	101779	198.0	1.59	1.6e-03
Michler's ketone	90948	268.4	4.07	3.4e-02
Mustard Gas	505602	159.1	2.03	5.6e-03
Naphthalene	91203	128.2	3.30	6.9e-02
Naphthol, b-	135193	144.2	2.84	2.6e-02
Naphthylamine, 1-	134327	143.2	2.25	1.0e-02
Naphthylamine, 2-	91598	143.2	2.28	1.1e-02
Nitrilotriacetic acid	139139	191.0	-0.18	9.7e-05
Nitro-o-anisidine, 5-	99592	152.7	1.47	2.5e-03
Nitrobiphenyl, 4-	92933	199.2	3.77	5.5e-02
Nitrofen	1836755	284.1	5.53	3.0e-01
Nitrophenol, 2-	88755	139.1	1.79	5.0e-03
Nitrophenol, 2-amino-4	99570	154.1	1.36	2.0e-03
Nitrophenol, 3-	554847	139.1	2.00	7.1e-03
Nitrophenol, 4-	100027	139.1	1.91	6.1e-03
Nitrophenol, 4-amino-2-	119346	154.1	0.96	1.1e-03
Nitropropane, 2-	79469	110.0	0.55	1.0e-03
Nitroso-di-n-butylamine, n-	924163	158.2	1.92	4.8e-03
Nitroso-N-ethylurea, n-	759739	117.1	0.23	0.00054
Nitroso-N-methylurea, n-	684935	103.1	-0.03	4.3e-04
Nitrosodiethanolamine, n-	1116547	134.0	-1.58	2.2e-05
Nitrosodiethylamine, n-	55185	88.0	0.48	1.2e-03
Nitrosodiphenylamine, p-	156105	198.2	3.50	3.6e-02
Nitrosomethylvinylamine, n-	4549400	86.1	0.00	5.7e-04
Nitrosomorpholine, n-	59892	116.1	-0.44	1.8e-04
Nitrosornicotine, n-	16543558	177.2	0.03	1.7e-04

TABLE 1: (Continued)

Chemical	CAS No.	MWT	log Kow	Kp (cm/hr)
Nitrosopiperidine, n-	100754	350.3	0.36	2.5e-05
Nonanol	143088	144.0	3.47	7.3e-02
Octanol	111875	130.0	2.97	3.9e-02
Parathion	56382	291.0	3.83	1.7e-02
PCB-chlorobiphenyl, 4-	2051629	292.0	6.50	1.3
PCB-hexachlorobiphenyl	26601649	361.0	6.72	0.71
Pentachloronitrobenzene	82688	295.3	4.64	0.059
Pentachlorophenol	87865	266.4	5.86	6.5e-01
Pentanol	71410	88.0	1.56	0.0071
Pentanone, 4-methyl-2-	108101	100.0	1.19	3.3e-03
Phenanthrene	85018	178.2	4.57	2.7e-01
Phenol	108952	94.0	1.46	5.5e-03
Phenol, 4,6-dinitro-2-methyl-	534521	198.1	2.12	3.8e-03
Propanol	71238	60.0	0.30	1.3e-03
Propiolactone, beta-	57578	575.8	-0.46	3.3e-04
Propylene oxide	75569	58.1	0.03	8.9e-04
Resorcinol	108463	110.1	0.80	1.5e-03
Safrole	94597	162.2	2.66	1.5e-02
Styrene	100425	104.1	2.95	5.5e-02
Styrene oxide	96093	120.0	1.61	4.9e-03
TCDD	1746016	322.0	6.8	1.4e+00
Tetrachlorethylene	127184	165.8	3.40	4.8e-02
Tetrachloroethane, 1,1,2,2-	79345	167.9	2.39	9.0e-03
Thioacetamide	62555	75.0	0.71	2.1e-03
Thiodianiline, 4,4'-	139651	216.0	2.03	2.5e-03
Thiourea	62566	76.0	-0.95	1.4e-04
Thymol	89838	150.2	3.30	5.1e-02
Toluene	108883	92.1	2.73	4.5e-02
Toluidine hydrochloride, o-	636215	143.2	0.00	2.1e-03
Toluidine,o-	95534	107.0	1.32	0.0037
Toxaphene	8001352	414.0	4.82	1.5e-02
Trichlorobenzene, 1,2,4-	120821	181.5	3.98	1.0e-01
Trichloroethane, 1,1,1-	71556	133.4	2.49	1.7e-02
Trichloroethane, 1,1,2-	79005	133.4	2.05	8.4e-03
Trichloroethylene	79016	131.4	2.42	1.6e-02
Trichlorofluoromethane	75694	137.4	2.53	1.7e-02
Trichlorophenol, 2,4,6-	88062	197.5	3.69	5.0e-02
Tris(2,3-dibromopropyl)phosphate	126727	697.6	4.98	3.6e-04
Tris(aziridiny)-para-benzoquinone	68768	231.3	-1.34	8.3e-06
Urea	57136	60.0	-2.11	2.6e-05
Vinyl bromide	593602	107.0	1.57	5.5e-03
Vinyl chloride	75014	62.5	1.36	7.3e-03
Water	7732185	18.0	-1.38	1.6e-04
Xylene, m-	108383	106.2	3.20	8.0e-02

TABLE 2: SCREENING LEVEL DERMAL ABSORPTION FRACTIONS (ABS) FROM SOIL

Compound Class		Absorption Fraction ¹	References
Chlorinated Insecticides		0.05	Wester, et al., 1990a; Wester, et al., 1992a
Polynuclear Aromatic Hydrocarbons		0.15	Wester, et al., 1990a
Organophosphates		0.25	Cal/EPA Office of Environmental Health Hazard Assessment
Pentachlorophenol		0.25	Wester, et al., 1993b
Polychlorinated Dibenzo-p-dioxins and Dibenzofurans		0.03	USEPA, 1992
Polychlorinated Biphenyls (PCB)		0.15	Wester, et al., 1993c
Other Organic Chemicals		0.10	SCAQMD, 1988
Cadmium		0.001	Wester, et al., 1992b
Arsenic		0.03	Wester, et al., 1993a
Hexavalent Chromium		0%	Not shown to be a systemic carcinogen via dermal exposure
Other metals and complexed cyanides		0.01	SCAQMD, 1988
Free Cyanide		0.10	SCAQMD, 1988
<p>1. Dermal absorption values from soil are based on, in order of preference: in vivo, animal studies on dermal absorption from soil; in vivo, animal studies on dermal absorption from an applicable cosolvent; in vitro, human skin dermal absorption studies; in vitro, animal skin dermal absorption studies. Actual dermal absorption from soil may vary from these estimates due to exposure conditions or soil characteristics which differ from the experimental conditions.</p>			

TABLE 3: PHYSICAL AND CHEMICAL PROPERTIES FOR VOLATILE COMPOUNDS (OSA, Jul-93)

Chemical	MW (g/mol)	Hc (atm-m ³ /mol)	Di (cm ² /sec)	Koc (l/kg)	S (mg/l)	VP (mm Hg)	Log Kow	BP Celsius	MP Celsius
Acetone	58.0	3.67E-05	0.103	2.20	1000000.00	231	-0.24	56.2	-95.4
Benzene	78.1	5.43E-03	0.088	65.00	1791.00	95	2.13	80.1	5.5
Carbon tetrachloride	154.0	3.04E-02	0.080	110.00	805.00	114	2.83	76.5	-23
Chlorobenzene	113.0	3.45E-03	0.072	160.00	471.70	11.9	2.84	132	-45.6
Chloroform	119.0	4.35E-03	0.089	31.00	7970.00	246	1.97	61.7	-63.5
1,2-Dibromoethane (EDB)	188.0	3.20E-04	0.073	28.10	3400.00	-	-	-	-
1,2-Dichlorobenzene	147.0	1.20E-03	0.130	1148.00	156.00	1.5	3.83	180.5	-17
1,4-Dichlorobenzene	147.0	1.50E-03	0.130	1175.00	87.00	1.8	3.52	174	53.1
1,1-Dichloroethane	99.0	5.87E-03	0.091	30.00	5060.00	227	1.79	57.3	-97
1,2-Dichloroethane (EDC)	99.0	9.77E-04	0.091	14.00	8524.00	78.7	1.48	83.5	-35.4
1,1-Dichloroethylene	97.0	1.54E-01	0.079	65.00	400.00	-	-	-	-
1,2-Dichloroethylene (trans)	97.0	6.72E-03	0.079	59.00	6300.00	340	2.06	48	-50
1,2-Dichloropropane	113.0	2.07E-03	0.080	51.00	2740.00	49.7	1.99	96.4	-100.5
Ethylbenzene	106.2	8.44E-03	0.075	220.00	161.00	9.5	3.15	136.2	-95
Methylene chloride	85.0	2.68E-03	0.101	8.80	13000.00	435	1.25	39.8	-95.1
Methyl ethyl ketone	72.0	1.05E-05	0.090	4.50	239000.00	90.6	0.29	79.6	-86.4
PAH Acenaphthene	154.2	1.20E-03	0.064	4600.00	3.88	-	-	-	-
PAH Anthracene	178.0	3.40E-05	0.058	12589.00	0.08	-	-	-	-
PAH Fluorene	166.2	6.42E-05	0.061	7900.00	1.90	-	-	-	-
PAH Naphthalene	128.2	5.00E-04	0.069	1288.00	31.70	0.082	3.3	217.9	80.2
Styrene	104.2	2.81E-03	0.071	360.00	310.00	6.6	2.95	145.2	-30.6
1,1,2,2-Tetrachloroethane	168.0	4.55E-04	0.073	218.78	2962.00	6.1	2.39	146.5	-36
Tetrachloroethylene (PCE)	165.8	1.49E-02	0.072	660.69	150.30	18.5	3.4	121	-19
Toluene	92.0	5.94E-03	0.078	257.04	534.80	28.4	2.73	110.6	-95
1,1,1-Trichloroethane	133.0	8.00E-03	0.080	150.00	1495.00	123.7	2.49	74.1	-30.4
1,1,2-Trichloroethane	133.0	1.20E-03	0.080	56.23	4420.00	30.3	2.07	113.8	-36.5
Trichloroethylene (TCE)	131.0	1.03E-02	0.081	125.89	1100.00	69	2.42	87	-73
Xylene (mixed)	106.2	5.30E-03	0.087	240.00	200.00	-	-	-	-

TABLE 4: SAMPLE EXPOSURE PATHWAY ANALYSIS FOR AN ECOLOGICAL SCREENING EVALUATION

Habitat Type	Potential Contaminants or Classess of Contaminants of Concern	Contaminated Media	Food Web Exposure	Potential Exposure Pathway	Complete Exposure Pathway
Chaparral	DDT	Soil		Direct Ingestion	Yes
	DDT	Soil	Invertebrates to Mouse	Ingestion of Prey	Yes
	Chloroform	Ground Water		Inhalation of Soil Gases	Yes
	Chloroform	Ground Water		Direct Ingestion	No
Footnote a	Footnote b		Footnote c	Footnote d	Footnote e

- Examples of habitat types include freshwater wetland, conifer forest, oak woodland and riparian.
- Indicate the specific chemical or family of chemicals, based on potential significance to the risk assessment. physical or chemical properties such as volatility, bioaccumulative potential, tendency to sorb to soils or sediments and water solubility may be important.
- Indicate the food web transfers for those indirect exposures through the food web.
- Indicate the potential exposure pathway such as inhalation of volatile compounds from surface or subsurface contamination, incidental soil or sediment ingestion, ingestion of contaminated food items, or dermal contact with contaminated media.
- Indicate whether the potential exposure pathway is complete given site-specific characteristics.

APPENDIX B

(Note: See Errata Sheet, Item 3, at end of Chapter 2.)

Volatile Emission Model (EPA, 1991; 1992b; 1992c)

Step 1: Calculate the Saturation Concentration

Use soil bulk concentrations to calculate emission rates, first estimate the saturation concentration (C_{sat}) for each contaminant in the vadose zone. C_{sat} for each contaminant is the concentration at which the adsorptive limit of the soil plus the theoretical dissolution limit of the contaminant in the available soil moisture has been reached. Concentrations greater than C_{sat} indicate "free-phase" contaminants within the soil matrix. In such an instance, the VOC emission model contained in Step 2 is not valid, and this screening procedure cannot be used.

$$C_{sat} = \frac{(K_d \times C_w \times \beta) + (C_w \times P_w) + (C_w \times H' \times P_a)}{\beta}$$

Where:

C_{sat} = soil saturation concentration, mg/kg

C_w = Upper limit of free moisture in soil (mg/L-water),
= $S \times \Theta_m$

Where:

S = solubility of contaminant in water, mg/L-water
(values can be found in Table 4 of Appendix C)

Θ_m = soil moisture content, kg-water/kg-soil
(default = 0.1)

β = soil bulk density (kg/L) (default = 1.5)

P_w = water filled soil porosity (unitless)
= $P_t - P_a$ (default = 0.434 - 0.284 = 0.15)

Where:

P_t = total soil porosity (unitless)
= $1 - \beta/\sigma$
= 0.434

Where:

β = soil bulk density,
(default = 1.5 g/cm³)
 σ = particle density,
(default = 2.65 g/cm³)

$$\begin{aligned}
 P_a &= \text{air-filled porosity (unitless)} \\
 &= P_t - \beta \Theta_m \\
 &= 0.284
 \end{aligned}$$

Where:

$$\begin{aligned}
 \beta &= \text{soil bulk density, g/cm}^3, \text{ (default = 1.5)} \\
 \Theta_m &= \text{soil moisture content,} \\
 &\text{cm}^3/\text{g (= g-water/g-soil), (default = 0.1)}
 \end{aligned}$$

$$\begin{aligned}
 H' &= \text{Henry's Law constant (unitless)} \\
 &= H_c \times 41
 \end{aligned}$$

Where:

$$\begin{aligned}
 41 &= \text{a conversion factor to change } H_c \text{ to dimensionless form} \\
 H_c &= \text{the Henry's Law constant, atm-m}^3/\text{mole}
 \end{aligned}$$

$$K_d = \text{soil/water partition coefficient, cm}^3\text{-water/g-soil} \quad (= \text{L/kg})$$

$$K_d = K_{oc} \times f_{oc}$$

Where:

$$K_{oc} = \text{organic carbon partition coefficient, cm}^3\text{-water/g-soil} \quad (= \text{L/kg})$$

(Values can be found in Table 4 of Appendix C.)

$$f_{oc} = \text{fraction of organic carbon in soil, g/g}$$

(default = 0.02)

If K_d and/or K_{oc} are not available in Table 4 or in the scientific literature, then estimate them as follows. Use one of the following equations based on the chemical class closest to the subject contaminant.

For aromatic or polynuclear aromatic contaminants:

$$K_{oc} = 10^{((1.00 \log K_{ow}) - 0.21)}$$

For herbicides, fungicides, and non-chlorinated insecticides:

$$K_{oc} = 10^{((1.029 \log_{ow}) - 0.18)}$$

For contaminants which do not fit into either of the classes listed above, use this third equation, which is based primarily on pesticides:

$$K_{oc} = 10^{((0.544 \log K_{ow}) + 1.377)}$$

Where:

K_{oc} = organic carbon partition coefficient, L/kg (mL/g)

K_{ow} = octanol/water partition coefficient, L/kg (mL/g)

Step 2: Calculate the Total Emission Rate

If bulk soil concentrations do not exceed C_{sat} , then calculate an emission rate for each contaminant using the equation below. This equation assumes the bulk soil concentration of the contaminant is less than the saturation concentration, C_{sat} . The default values are the same as those stated in EPA (1991b), except for the area of contamination, (A), the fraction of organic carbon in the soil (f_{oc}), and the exposure interval (T). The default value for the exposed surface area is equal to 5,000 square feet ($4.84 \times 10^6 \text{ cm}^2$ or 484 m^2), the minimum dimensions of a residential lot in California (Hadley and Sedman, 1990). The default value for soil organic carbon is 0.02 (1992b). The default values for exposure interval are 30 yr for carcinogenic risk and 6 yr for non-carcinogenic hazard.

$$E = \frac{2 A D_{ei} P_a K_{as} C_i \times 10^3 \text{ mg/g}}{\sqrt{\pi \alpha T}}$$

Where:

E_i = average emission rate of contaminant i over the residential lot during the exposure interval, mg/sec

A = area of contamination, cm^2 ; default = $4.84 \times 10^6 \text{ cm}^2$,

D_{ei} = effective diffusivity of compound, cm^2/sec
 = $D_i (P_a^{3.33}/P_t^2)$

Where:

D_i = diffusivity in air, cm^2/s .
 (Values are shown in Appendix C, Table 4. If the desired value is not found in Table 4, refer to USEPA (1992b), equation (9), page 13.)

P_t = total soil porosity, unitless
 = $1 - (\beta/\rho)$

Where:

β = soil bulk density, g/cm³ (default = 1.5 g/cm³)

ρ = particle density, g/cm³ (default = 2.65 g/cm³)

$$P_t = 0.434$$

P_a = air filled soil porosity, unitless
= $P_t - \Theta_m \beta$

Where:

Θ_m = soil moisture content, cm³/g (default = 0.1 cm³/g)

$$P_a = 0.284$$

K_{as} = soil/air partition coefficient, g/cm³
= $(H_c/K_d) \times 41$

Where:

H_c = Henry's Law constant, atm-m³/mole

41 = conversion factor to change H_c to dimensionless form

K_d = soil-water partition coefficient (cm³-water/g-soil)
(= L/kg)

C_i = bulk soil concentration of contaminant i, g/g-soil

T = exposure interval, sec (default = 30 yr = 9.5×10^8 seconds)

α = conversion factor composed of quantities defined above

$$\alpha = \frac{D_{ei} \times P_a}{P_a + [(\rho)(1 - P_a)/K_{as}]}$$

DERIVATIONS FOR SCREENING EVALUATION EQUATIONS

Original Equations:

$$\begin{aligned}
 \text{Risk}_{\text{water}} = & \text{SF}_o \times \text{C}_w \times \frac{\text{IR}_{w,\text{adult}} \times \text{EF} \times \text{ED}_{\text{adult}}}{\text{BW}_{\text{adult}} \times \text{AT} \times 365 \text{ day/yr}} \\
 & + \text{SF}_o \times \text{C}_w \times \frac{\text{IR}_{w,\text{child}} \times \text{EF} \times \text{ED}_{\text{child}}}{\text{BW}_{\text{child}} \times \text{AT} \times 365 \text{ day/yr}} \\
 & + \text{SF}_o \times \text{C}_s \times \frac{\text{SA}_{\text{adult}} \times \text{K}_p \times \text{EF} \times \text{ED}_{\text{adult}} \times \text{ET}_{\text{adult}} \times 1 \text{ L/1000 cm}^3}{\text{BW}_{\text{adult}} \times \text{AT} \times 365 \text{ days/yr}} \\
 & + \text{SF}_o \times \text{C}_s \times \frac{\text{SA}_{\text{child}} \times \text{K}_p \times \text{EF} \times \text{ED}_{\text{child}} \times \text{ET}_{\text{child}} \times 1 \text{ L/1000 cm}^3}{\text{BW}_{\text{child}} \times \text{AT} \times 365 \text{ days/yr}}
 \end{aligned}$$

Default exposure factors:

BW	=	body weight, (70 kg adult; 15 kg child)
AT	=	averaging time, 70 yr
EF	=	exposure frequency, 350 day/yr (EPA, 1991)
ED	=	exposure duration (24 yr adult; 6 yr child)
IR _w	=	intake rate (adult = 2 L/day; child = 1L/day)
ET	=	exposure time during showering/bathing (adult, 15 min/shower = 0.25 hr/day; child, four 15 min baths/week = 0.14 hr/day [USEPA, 1992a])
SA	=	skin surface area available for contact (cm ²) (adults, 23,000 cm ² [USEPA, 1992a]; child, 7,200 cm ² [USEPA, 1989b])
K _p	=	chemical-specific dermal permeability coefficient from water, cm ² /hr.

Reduced Equations:

$$\text{Risk}_{\text{water}} = (\text{SF}_o \times \text{C}_w \times 0.0149) + (\text{SF}_o \times \text{C}_w \times 0.0325 \times \text{K}_p)$$

FIGURE 1: DERIVATION OF RISK EQUATION FOR non-VOCs IN WATER

Original Equations:

$$\begin{aligned}
 \text{Risk}_{\text{water}} = & \text{SF}_o \times C_w \times \frac{\text{IR}_{w,\text{adult}} \times \text{EF} \times \text{ED}_{\text{adult}}}{\text{BW}_{\text{adult}} \times \text{AT} \times 365 \text{ day/yr}} \\
 & + \text{SF}_o \times C_w \times \frac{\text{IR}_{w,\text{child}} \times \text{EF} \times \text{ED}_{\text{child}}}{\text{BW}_{\text{child}} \times \text{AT} \times 365 \text{ day/yr}} \\
 & + \text{SF}_o \times C_s \times \frac{\text{SA}_{\text{adult}} \times K_p \times \text{EF} \times \text{ED}_{\text{adult}} \times \text{ET}_{\text{adult}} \times 1 \text{ L/1000 cm}^3}{\text{BW}_{\text{adult}} \times \text{AT} \times 365 \text{ days/yr}} \\
 & + \text{SF}_o \times C_s \times \frac{\text{SA}_{\text{child}} \times K_p \times \text{EF} \times \text{ED}_{\text{child}} \times \text{ET}_{\text{child}} \times 1 \text{ L/1000 cm}^3}{\text{BW}_{\text{child}} \times \text{AT} \times 365 \text{ days/yr}}
 \end{aligned}$$

Default exposure factors:

BW	=	body weight, (70 kg adult; 15 kg child)
AT	=	averaging time, 70 yr
EF	=	exposure frequency, 350 day/yr (EPA, 1991)
ED	=	exposure duration (24 yr adult; 6 yr child)
IR _w	=	intake rate (adult = 2 L/day; child = 1L/day)
ET	=	exposure time during showering/bathing (adult, 15 min/shower = 0.25 hr/day; child, four 15 min baths/week = 0.14 hr/day [USEPA, 1992a])
SA	=	skin surface area available for contact (cm ²) (adults, 23,000 cm ² [USEPA, 1992a]; child, 7,200 cm ² [USEPA, 1989b])
K _p	=	chemical-specific dermal permeability coefficient from water, cm ² /hr.

Reduced Equations:

$$\text{Risk}_{\text{water}} = (\text{SF}_o \times C_w \times 0.0149) + (\text{SF}_o \times C_w \times 0.0325 \times K_p)$$

FIGURE 2: DERIVATION OF RISK EQUATION FOR VOCs IN WATER

Original Equations:

$$\text{Risk}_{\text{voc,water}} = \text{Risk}_{\text{water}} + \frac{\text{SF}_i \times C_w \times \text{IR}_{\text{voc,adult}} \times \text{EF} \times \text{ED}_{\text{adult}}}{\text{BW}_{\text{adult}} \times \text{AT} \times 365 \text{ days/yr}} \\ + \frac{\text{SF}_i \times C_w \times \text{IR}_{\text{voc,child}} \times \text{EF} \times \text{ED}_{\text{child}}}{\text{BW}_{\text{child}} \times \text{AT} \times 365 \text{ days/yr}}$$

Default exposure factors:

BW	=	body weight, (70 kg adult; 15 kg child)
AT	=	averaging time, 70 yr
EF	=	exposure frequency, 350 day/yr (EPA, 1991)
ED	=	exposure duration (24 yr adult; 6 yr child)
IR _{voc}	=	intake from inhalation of VOCs from domestic use of water is equivalent to the amount of ingested water (USEPA, 1989c).

Reduced Equations:

$$\text{Risk}_{\text{water}} = [0.0149 \times ((\text{SF}_o \times C_w) + (\text{SF}_i \times C_w))] + (\text{SF}_o \times C_w \times 0.0325 \times K_p)$$

FIGURE 3: DERIVATION OF HAZARD EQUATION FOR non-VOCs IN WATER

Original Equation:

$$\text{Hazard}_w = \frac{(1/\text{RfD}_o) \times C_w \times \text{IR}_w \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT} \times 365 \text{ day/yr}} + \frac{(1/\text{RfD}_o) \times C_w \times \text{SA} \times K_p \times \text{ET} \times \text{EF} \times \text{ED} \times (1 \text{ L}/1000 \text{ cm}^3)}{\text{BW} \times \text{AT} \times 365 \text{ day/yr}}$$

Default exposure factors (for childhood exposure from birth to six years of age):

BW	=	body weight = 15 kg
AT	=	averaging time = 6 yr
EF	=	exposure frequency = 350 day/year (EPA, 1991)
ED	=	exposure duration = 6 yr
IR _w	=	daily intake of water = 1 L/day
ET	=	exposure time = 0.14 hours/day; based on the assumption of four 15 minute baths taken weekly.
SA	=	skin surface area (cm ²) exposed during bathing = 7,200 cm ²
		K _p = chemical-specific dermal permeability coefficient from water

Reduced Equations:

$$\text{Hazard}_{\text{water}} = ((C_w/\text{RfD}_o) \times 0.0639) + ((C_w/\text{RfD}_o) \times 0.0644 \times K_p)$$

FIGURE 4: DERIVATION OF HAZARD EQUATION FOR VOCs IN WATER

Original Equation:

$$\text{Hazard}_w = (1/RfD_o) \times \frac{C_w \times IR_w \times EF \times ED}{BW \times AT \times 365 \text{ day/yr}} +$$

$$(1/RfD_i) \times \frac{C_w \times IR_{w,voc} \times EF \times ED}{BW \times AT \times 365 \text{ day/yr}} +$$

$$(1/RfD_o) \times \frac{C_w \times SA \times K_p \times ET \times EF \times ED \times (1 \text{ L}/1000 \text{ cm}^3)}{BW \times AT \times 365 \text{ days/yr}}$$

Default exposure factors (for childhood exposure from birth to six years of age):

- BW = body weight = 15 kg
 AT = averaging time = 6 yr
 EF = exposure frequency = 350 day/year (EPA, 1991)
 ED = exposure duration = 6 yr
 $IR_{w,voc}$ = intake from inhalation of VOCs ~ ingestion rate = 1L/day
 (A chemical is a VOC if it has a vapor pressure greater than 1×10^{-3} mm Hg or a Henry's Law constant greater than 1×10^{-5} atm-m³/mole). The increased intake for VOCs is to account for the additional exposure via inhalation of volatilized compounds from domestic use of water (USEPA, 1989c).
 ET = exposure time = 0.14 hours/day; based on the assumption of four 15 minute baths taken weekly.
 SA = skin surface area (cm²) exposed during bathing = 7,200 cm²
 K_p = chemical-specific dermal permeability coefficient from water

Reduced Equations:

$$\text{Hazard}_{\text{water}} = [0.0639 \times ((C_w/RfD_o) + (C_w/RfD_i))] + [(C_w/RfD_o) \times 0.0644 \times K_p]$$

FIGURE 5: DERIVATION OF RISK EQUATION FOR SOIL

Original Equation:

$$\begin{aligned}
 \text{Risk}_{\text{soil}} = & \text{SF}_o \times C_s \times \frac{\text{IR}_{s,\text{adult}} \times \text{EF} \times \text{ED}_{\text{adult}} \times 10^{-6} \text{ kg/mg}}{\text{BW}_{\text{adult}} \times \text{AT} \times 365 \text{ days/yr}} \\
 & + \text{SF}_o \times C_s \times \frac{\text{IR}_{s,\text{child}} \times \text{EF} \times \text{ED}_{\text{child}} \times 10^{-6} \text{ kg/mg}}{\text{BW}_{\text{child}} \times \text{AT} \times 365 \text{ days/yr}} \\
 & + \text{SF}_o \times C_s \times \frac{\text{SA}_{\text{adult}} \times \text{AF} \times \text{ABS} \times \text{EF}_{\text{adult}} \times \text{ED}_{\text{adult}} \times 10^{-6} \text{ kg/mg}}{\text{BW}_{\text{adult}} \times \text{AT} \times 365 \text{ days/yr}} \\
 & + \text{SF}_o \times C_s \times \frac{\text{SA}_{\text{child}} \times \text{AF} \times \text{ABS} \times \text{EF}_{\text{child}} \times \text{ED}_{\text{child}} \times 10^{-6} \text{ kg/mg}}{\text{BW}_{\text{child}} \times \text{AT} \times 365 \text{ days/yr}}
 \end{aligned}$$

Default exposure factors:

- AT = averaging time = 70 years
- EF = exposure frequency for soil ingestion = 350 day/yr (EPA, 1991a)
= exposure frequency for dermal contact = 2 events/week or 100 day/yr for adults, and 7 events/week or 350 days/year for children (USEPA, 1991a)
- ED = exposure duration; 24 yr for adults and 6 yr for children
- IR_s = incidental soil ingestion rate, mg/day; 100 mg/day for adults and 200 mg/day for children (USEPA, 1991a)
- BW = body weight; adults = 70 kg, children = 15 kg (USEPA, 1991a)
- SA = skin surface area exposed (cm²); adult = 5,800 cm²/day, child = 2,000 cm²/day (DTSC, 1992, Chapter 1)
- AF = soil to skin adherence factor, mg/cm²; default value is 1.00 mg/cm² (EPA, 1992)
- ABS = absorption fraction of chemical from soil

Reduced Equation:

$$\begin{aligned}
 \text{Risk}_{\text{soil}} = & (\text{SF}_o \times C_s \times 4.7 \times 10^{-7}) + (\text{SF}_o \times C_s \times 1.1 \times 10^{-6}) + \\
 & (\text{SF}_o \times C_s \times 7.8 \times 10^{-6} \times \text{ABS}) + (\text{SF}_o \times C_s \times 1.1 \times 10^{-5} \times \text{ABS})
 \end{aligned}$$

FIGURE 6: DERIVATION OF HAZARD EQUATION FOR SOIL

Original Equation:

$$\begin{aligned} \text{Hazard}_{\text{soil}} = & (1/\text{RfD}_o) \times C_s \times \frac{\text{IR}_s \times \text{EF} \times \text{ED} \times 10^{-6} \text{ kg/mg}}{\text{BW} \times \text{AT} \times 365 \text{ day/yr}} \\ & + (1/\text{RfD}_o) \times C_s \times \frac{\text{SA} \times \text{AF} \times \text{ABS} \times \text{EF} \times \text{ED} \times 10^{-6} \text{ kg/mg}}{\text{BW} \times \text{AT} \times 365 \text{ days/yr}} \end{aligned}$$

Default exposure factors (based on childhood exposure from birth to six years of age):

- IR_s = incidental soil ingestion rate = 200 mg/day
- EF = exposure frequency, 350 days/year for soil ingestion and dermal contact (EPA, 1991)
- ED = exposure duration = 6 years
- BW = body weight = 15 kg (USEPA, 1991a)
- AT = averaging time = 6 years
- SA = skin surface area exposed = 2,000 cm²
- AF = soil to skin adherence factor = 1 mg/cm² (USEPA, 1992a)
- ABS = absorption fraction of chemical from soil (See Table 3)

Reduced Equation:

$$\text{Hazard}_{\text{soil}} = [(C_s/\text{RfD}_o) \times 1.28 \times 10^{-5}] + [(C_s/\text{RfD}_o) \times 1.28 \times 10^{-4} \times \text{ABS}]$$

FIGURE 7: DERIVATION OF RISK EQUATION FOR AIR

Original Equation:

$$\text{Risk}_{\text{air}} = \text{SF}_i \times \text{C}_a \times \frac{\text{IR}_{\text{adult}} \times \text{EF} \times \text{ED}_{\text{adult}}}{\text{BW}_{\text{adult}} \times \text{AT} \times 365 \text{ days/yr}} \\ + \text{SF}_i \times \text{C}_a \times \frac{\text{IR}_{\text{child}} \times \text{EF} \times \text{ED}_{\text{child}}}{\text{BW}_{\text{child}} \times \text{AT} \times 365 \text{ day/yr}}$$

Default exposure factors for risk:

BW	=	body weight = 70 kg for adults, 15 kg for children
AT	=	averaging time, 70 yr
EF	=	exposure frequency, 350 day/yr (EPA, 1991)
ED	=	exposure duration = 24 yr for adults, 6 yr for children
IR _a	=	inhalation rate = 20 m ³ /day for adults, 10 m ³ /day for children (EPA, 1989a; Schum, et al., 1993).

Reduced Equation:

$$\text{Risk}_{\text{air}} = (\text{SF}_i \times \text{C}_a \times 0.0939) + (\text{SF}_i \times \text{C}_a \times 0.0548) \\ = \text{SF}_i \times \text{C}_a \times 0.149$$

FIGURE 8: DERIVATION OF HAZARD EQUATION FOR AIR

Original Equation:

$$\text{Hazard}_{\text{air}} = (1/\text{RfD}_i) \times C_a \times \frac{\text{IR} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT} \times 365 \text{ day/yr}}$$

Default exposure factors (based on childhood exposure from birth to six years):

BW = body weight, 15 kg

AT = averaging time, 6 years

EF = exposure frequency, 350 day/yr

ED = exposure duration, 6 yr

IR_a = inhalation rate, 10 m³/day (Schum, et al., 1993)

Reduced Equation:

$$\text{Hazard}_{\text{air}} = (1/\text{RfD}_i) \times C_a \times 0.639$$